FHWA Study Tour for
Road Safety Audits
Part 2—Case Studies & Checklists

FHWA's
Scanning Program

U.S. Department of Transportation
Federal Highway Administration

NOTICES

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FHWA Study Tour for

ROAD SAFETY AUDITS
PART 2

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FHWA International Technology Exchange Programs

The FHWA's international programs focus on meeting the growing demands of its partners at the Federal, State, and local levels for access to information on state-of-the-art technology and the best practices used worldwide. While the FHWA is considered a world leader in highway transportation, the domestic highway community is very interested in the advanced technologies being developed by other countries as well as innovative organizational and financing techniques used by the FHWA's international counterparts.

International Technology Scanning Program

The International Technology Scanning Program accesses and evaluates foreign technologies and innovations which could significantly benefit U.S. highway transportation systems. This approach allows for advanced technology to be adapted and put into practice much more efficiently without spending scarce research funds to recreate advances already developed by other countries.

Access to foreign innovations is strengthened by U.S. participation in the technical committees of international highway organizations and through bilateral technical exchange agreements with selected nations. The program is undertaken cooperatively with the American Association of State Highway Transportation Officials and its Select Committee on International Activities, and the Transportation Research Board's National Highway Research Cooperative Program (Panel 20-36), the private sector, and academia.

Priority topic areas are jointly determined by FHWA and its partners. Teams of specialists in the specific areas of expertise being investigated are formed and sent to countries where significant advances and innovations have been made in technology, management practices, organizational structure, program delivery and financing. Teams usually comprise Federal and State highway officials, private sector and industry association representatives as well as the academic community.

The FHWA has undertaken over 20 of these reviews and disseminated results nationwide. Topics have covered pavements, bridge construction and maintenance, contracting, intermodal transport, organizational management, winter road maintenance, safety, intelligent transportation systems, planning, and policy. Findings are recommended for follow-up with further research and pilot or demonstration projects to verify adaptability to the United States. Information about the scan findings, and results of pilot programs are then disseminated throughout the country to State and local highway transportation officials and the private sector for implementation.

This program has resulted in significant improvements and savings in road program technologies and practices throughout the United States, particularly in the areas of structures, pavements, safety, and winter road maintenance. Joint research and technology-sharing projects have also been launched with international counterparts, further conserving resources and advancing the state-of-the-art.

For a complete list of International Technology Scanning topics and to order free copies of the reports, please see the inside back cover of this publication.

Website: www.international.fhwa.dot.gov **E-Mail: international@fhwa.dot.gov**

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1.0 INTRODUCTION

Part 2 of the FHWA report on Road Safety Audits was prepared to provide the following:

- Additional detail on road safety organizations and the development of safety policies in Australia and New Zealand. This complements the information in Section 2 of Part 1.
- An overview of checklists used in the road safety audit process using examples from the Austroads guide and other publications.
- Examples of actual safety audit reports.
- A summary report evaluating the results of safety audits.

2.0 ORGANIZATION AND STRUCTURE OF SAFETY PROGRAMS IN AUSTRALIA AND NEW ZEALAND

2.1 Australia

2.1.1 Government Structure

Australia is similar in size to the continental United States and consists of six states and two territories. Most of its 18 million people live in the coastal urban centers. Like the United States, the Commonwealth of Australia has a bicameral Federal government with a Senate and a House of Representatives. The Senate has 12 representatives from each state and 2 from each territory, who are elected for 6-year terms. The 148 members of the House of Representatives are apportioned by population of the states and territories, and terms are for 3 years. The leader of the political party that controls the majority of the seats in the House is designated as the Prime Minister. The Cabinet, selected from among members of Parliament, exercises control over the executive branch of government and is responsible to the Parliament.

In five of the six states the legislature is bicameral; in Queensland the legislature is unilateral. Each state is led by a premier, who is the leader of the party that holds the most seats in the state's lower house.

Australia has two territories: the Northern Territory and the Capital Territory. The Capital Territory is a region similar to the District of Columbia, an area designated to accommodate the federal government.

Australia ranks fifth in the world in number of automobiles per capita. Growth patterns in its major cities, where the population is concentrated, are similar to those in the United States. Low-density, dispersed developments are highly dependent on automobiles, resulting in increased auto usage and limited transit service.

2.1.2 Transportation and Road Safety Organizations

The Cabinet level organization responsible for transportation is the Department of Transport and Regional Development (DTRD). DTRD is structured along modal lines much like the U.S. DOT. Its recent activities have included examination of issues related to railway reform and infrastructure management. In Australia, the states and territories generate most of the initiatives relating to roadway transportation systems and safety. The DTRD is responsible for the National Highway System, a network of 18,500 km of roads that links the major cities in Australia and is the backbone of its freight transportation system. The Federal Government spends about A$800 million per year on construction and maintenance of the National Highway. Funding is provided directly to states and territories.

The Federal Office of Road Safety (FORS) is the agency within the DTRD responsible for road safety. The mission of FORS is to reduce road trauma. It is organized in two major branches as shown in the box on the following page.

FORS is only one of many organizations involved in setting National Road Safety Policy. The Ministerial Council for Road Transport consists of the Ministers of

Branches of FORS	
Road User	Motor Transport
Strategies & Black Spots	Client Operations
Road Transport Regulations	International Projects
Statistical Analysis	Vehicle Standards, R&D
Research	Policy & Emissions
Public Education & Liaison	----------

Transport from each of the states and territories and the Commonwealth Minister of Transport. It operates as a policy-making body, although the states and territories are not legally bound to follow the adopted policies. The same entities also form another group, the Australian Transport Council. The Council is responsible for implementing the national road safety strategy.

In 1992, the National Road Transport Commission was formed and charged with the task of developing nationally consistent standards and regulations for road transport. It provides information and research and drafts road-related laws for the Transport Council to consider. The Commission receives input from a variety of advisory groups and other entities including state transport agencies, Austroads, and the Australian Roads Research Board, Transport Research, Ltd. (ARRB TR).

Austroads is an organization similar to AASHTO in the United States. It was established in 1989 to provide government and industry with information and advice on national road-related issues such as transport policy, road use management, road technology, and the environment. It is not a policy making body and is governed by a consortium of officials from the states and territories, the DTRD, the Australian Local Government Association, and Transit New Zealand. Its approach is to examine issues that are common among all roadway projects and increase safety behavior through voluntary compliance.

ARRB TR conducts research of national interest for the Commonwealth. It disseminates research results to public and private organizations, governments, and individuals in the areas of road design, location, construction, and maintenance. Funding for ARRB is provided by federal, state, and territorial road transport agencies. It also provides research and consulting services to other countries.

2.1.3 National Road Safety Strategy

In 1992, the National Road Safety Strategy was developed as Australia's first national and comprehensive approach for reducing traffic fatalities. It was formulated at a time when road fatalities were decreasing but in a period when data indicated that

- Australia was in a period of economic recovery,
- the population was growing,
- the vehicle fleet was growing, and
- greater use of automobiles was projected.

The Road Safety Strategy was developed with eight strategic objectives:

- Major stakeholder ownership and participation in road safety.
- Road safety as a major public health issue.

- Road safety as a major economic strategy.
- Road safety as a priority in the management of transport and land use.
- Safer vehicles, safer roads, and safer road users.
- Integrated framework for road safety planning and action.
- Strategic research and development program.
- Rationalization of federal, state, and territorial programs.

The document set forth objectives through the year 2000 for reducing road trauma and was prepared with contributions from more than 70 stakeholders from federal, state, and local government, business groups, and community organizations. The projected 10-year benefits from implementing the strategy were 3,000 to 4,000 lives saved and A$1.5 billion (US$1.2 billion) in economic benefits. The strategy was designed to be flexible; not imposing actions on the stakeholders, but enabling them to address their own issues while making commitments to national goals. It encouraged the adoption and implementation of the latest technologies and best practices. A National Road Safety Strategy Task Force was established to oversee implementation of the strategy. Its specific objectives were to

- help in the exchange of information,
- develop national road safety targets,
- advance and review the strategy, and
- establish and coordinate research priorities.

This task force receives information from state transport agencies, Austroads, and other organizations. FORS provides information to the task force and oversees implementation of its recommendations.

In 1994 a National Road Safety Action Plan was developed. It was stated that all identified national actions under the National Road Safety Strategy will satisfy one or more of the following principles:

- Stimulate activity by all stakeholders, directed toward objectives and actions.
- Generate specific aims and expected outcomes.
- Provide for transfer of best or, at least, good practices between jurisdictions and stakeholders.
- Identify a broader national range of influences.
- Fill gaps between state and territory strategies.
- Enhance credibility and value of state, territory, local government, and private-sector strategies.
- Provide links to other national agendas, such as health, transport, education, enforcement, industry, city development, consumers, and ecologically sustainable

development, to improve rehabilitation of road crash victims.

- Address problems that transcend state and territorial boundaries; e.g., the Outback, long-distance freight.
- Promote national research and development focusing on coordination and evaluation.
- Provide for road safety to be assessed in major public transport and land-use initiatives.

In 1996, the 1994 Action Plan was updated, and the following 10 national priority actions were established:

- Rural and remote area safety.
- Aboriginal and Torres Strait Islander road safety.
- Enforcement resources.
- Speed management.
- Alcohol and drugs.
- Fatigue management strategy.
- Vehicle standards and cost-effective safety technology.
- Multimedia education.
- Improved safety for young and novice drivers.
- Vulnerable road users—pedestrians, seniors, motorcyclists, and bicyclists.

2.1.4 Safety Audits Within the National Road Safety Strategy

Road safety audits are entrenched in the National Road Safety Strategy. The audit process is addressed in a key objective—safer vehicles, safer roads and safer road users. FORS has identified the road safety audit as one of the national "best practices" that could be implemented to meet safety objectives. Austroads' *Road Safety Audit* is used as a guide to good practice. FORS supports this proactive rather than reactive approach to road safety and serves as the coordinator in the process, bringing all parties together. The states and territories are responsible for implementing and monitoring the road safety audits.

2.1.5 Road Safety Funding

In 1993-94, the level of Federal road funding was A$1,532 million (US$1.2 million). It has been increasing at about 2 percent per year. Approximately A$800 million (US$6.4 million) of these funds are designated as direct funding for the National Highway System. From fiscals 1993-94 to 1995-96, A$6 million (US$4.8 million) was allocated as direct funding to the states and territories for road safety. The remaining funds were distributed to the states and territories for national arterials and local roads. Starting in 1995-96, A$36 million (US$2.88 million) was earmarked directly for a hazard elimination or "black spot" program.

2.1.6 The Hazard Elimination or "Black Spot" Program

From 1990 to 1993, a federally supported black spot program was part of the overall

national safety program. This activity, similar to the Highway Safety Improvement Program (HSIP) in the United States, allocated funds to the states to improve sites that had crash histories and could demonstrate that proposed treatments would be cost-effective. In addition to federal support, individual states also established black spot programs. An evaluation of the program's effectiveness in the state of Victoria from 1992-93 to 1993-94 showed that the A$39.7 million (US$32 million) spent on black spot treatments resulted in a 17-percent reduction of casualty crash numbers, an 18-percent reduction in casualty costs to the community, a benefit/ cost ratio of 4.4, and a net present worth of benefits of A$144 million (US$112 million).

In 1996, funding for the Black Spot Program at the federal level was reintroduced, and it was expanded to include public interaction in the identification of black spots. Locations with three or more crashes per year are eligible for analysis by traffic engineers. Up to 20 percent of the projects will be undertaken as a result of road safety audits.

2.2 Victoria

Victoria has a population of approximately 4.5 million in an area of 227,600 square kilometers. It is the second most populated state in Australia, with 3 million people residing in the Melbourne metropolitan area. There are 3 million registered vehicles and a similar number of licensed drivers. The roadway network consists of 161,000 km of roads: 22,000 km under state control, 138,000 km of local roads and streets, and the remaining 1,000 km as part of the National Highway System.

The primary government responsibility for road safety is with the Ministry of Roads and Ports. The principal transportation agency for the state is the Victoria Roads Corporation, or VicRoads. VicRoads is a statutory corporation formed by Parliament in July 1989, during a period of privatization of government services. It was created from two acts: the Transport Act, which identified the road and transportation management functions; and the Road Safety Act, which focused on vehicle registration, driver licensing, and traffic regulations. VicRoads went from an organization that was responsible for full road construction, operation, and maintenance services to one with a functional management orientation. The organizational culture changed dramatically from basic engineering to customer-oriented business groups. More than 50 percent of the design functions are contracted and about 90 percent of maintenance functions are outsourced. Management personnel work under contract and can be terminated if performance requirements are not met.

VicRoads' responsibilities only encompass roads, but they do extend to railway grade crossings. Public transport is within the purview of another agency. As a private entity, VicRoads operates as a profit center and conducts other activities, such as research in foreign countries.

VicRoads consists of four core businesses:

- Road Safety
- Road Systems Management
- Traffic and Road Use Management
- Registration and Licensing

Each division is headed by a General Manager, who reports to the Chief Executive. Under each General Manager are regional and project managers to supervise individual programs and projects. For example, the Road Safety section has responsibility for road safety audits, black spot programs, speed management, and elimination of hazardous roadside obstacles.

Traffic fatalities in Victoria have dropped from a high of 1,061 in 1970 to 418 in 1995. The 1995 fatality rates were 1.4 fatalities per 10,000 vehicles and 9.3 fatalities per 100,000 population. Major factors that contributed to the drop were

- economic recession,
- drop in travel,
- speed camera enforcement,
- random breath-alcohol testing,
- massive black spot treatments, and
- intensive media coverage.

2.2.1 Road Safety Strategy

In 1995, the Victoria government developed a comprehensive strategy called "Safety First" that was designed to build on successful programs and set out areas for action in the following five years. The primary objective of Safety First is to further reduce the incidence, severity, and cost to the community of road crashes. These goals will be achieved through improved research and education, continued media campaigns focusing on attitudes and behaviors, attention to design and safety features of roads and vehicles, stringent enforcement of road laws, and coordination of the efforts of all related agencies.

Priority areas that have been identified are

- drunk driving,
- speeding,
- fatigue,
- restraint wearing,
- road design and quality,
- drivers in high-risk groups,
- motorcycle, bicycle, and pedestrian safety,
- heavy vehicle crashes,
- drugs and drinking, and
- occupant protection.

The program is organized into 2-week periods of intensive campaigns, during which extensive media coverage is given to each of the topics. These include television spots, newspaper features, and information distribution in the schools.

The roles of three key agencies—VicRoads, the Victoria Police, and the Transport Accident Commission (TAC)—are defined in the strategy. TAC is an insurance agency established by the government that provides mandatory accident health insurance for all Victoria drivers. It has provided millions of dollars over the past years for safety initiatives such as speed cameras, television safety commercials, and "booze buses," which are special vehicles used to test drivers for blood alcohol levels. Victoria

has a very aggressive policy to enforce the state-mandated maximum blood alcohol level of 0.05 for driving.

The strategy provides an umbrella for the diverse group of more than 500 organizations involved in one or more aspects of roadway safety in Victoria.

2.2.2 Road Safety Audits

Road safety audits have been under development in Victoria for three years. The Road Safety Section of VicRoads, which is responsible for management of road safety audits, gives the following reasons for conducting road safety audits:

- "We keep building black spots."
- Poor safety treatments observed at road work sites.
- Observed poor maintenance of safety features (e.g., delineation, safety barriers, etc.).
- Safety constraints from planning decisions.

VicRoads considers audits to be a critical element in a quality management process—the chance to improve quality with little increase in cost. All projects over A$5 million (US$4 million) are audited at all stages. Twenty percent of other projects are audited on a random basis at one or more stages. Safety audits in Victoria are conducted by independent contractors selected by VicRoads.

2.3 New South Wales

The Roads and Traffic Authority (RTA) has executive responsibility for road safety in New South Wales (NSW). It works with other stakeholders such as policy makers, local government, and the community to carry out the safety agenda.

The RTA has 7,000 employees with responsibilities in three broad areas:

- Road network infrastructure
- Driver and vehicle policy and regulation
- Road safety and traffic management

The management of RTA is decentralized, with programs and services in six regions in the state. Each region has primary responsibility for implementing road safety programs in its area. Programs are based on regional as well as state safety objectives to ensure that local issues are addressed. Links between RTA and professional organizations, community groups, and other government units on road safety matters are provided through the Roads and Traffic Advisory Council, the Road Safety Advisory Council, and the Road Safety Forum.

2.3.1 Road Safety Strategy

In 1991, NSW developed a road safety strategic plan, Road Safety 2000. The plan identified six key strategic issues, which are

- community involvement,

- safer people,
- safer roads,
- safer vehicles and equipment,
- strategic coordination, and
- transport and land use planning and management.

A progress report prepared in 1994 showed the following results during the period from 1988 to 1993, based on the averages of road trauma prior to the implementation of the strategy:

- 1,200 fewer deaths.
- 8,000 fewer serious fatalities.
- 950 fewer fatal crashes.
- 6,200 fewer serious casualty crashes.
- Estimated community savings of A$2.3 billion from the reduced number of crashes and casualties.

The actual number of fatalities dropped to 647 for 1994 from the 1988-90 average of 931. Comparable rate changes from 1988-90 to 1994 for fatalities per 100 million vehicle kilometers were 1.8 to 1.2, and fatalities per 100,000 of population dropped from 16.1 to 10.7.

The key features of the program include the following:

- Cities and counties have contributed.
- All highways have improved safety characteristics.
- Influences of speed, fatigue, and alcohol have been reduced.
- Restraint use has improved.
- Major black spots have been substantially reduced.
- There are reductions in bicycle and pedestrian accidents.
- Safety improvements have been highest among the young.

2.3.2 Funding

Funding for RTA safety programs exceeded A$80 million (US$64 million) in 1995. Of this total, A$30 million (US$24 million) was used to fund road safety development programs, such as community-based initiatives, enforcement, and information programs. An additional A$30 million (US$24 million) funded the Road Environment Safety Program. Specific allocations included black spot programs, A$11.5 million (US$8.8 million); road safety audits, A$5.5 million (US$4.4 million); and roadside enhancements, A$9 million (US$7.2 million).

2.3.3 Road Safety Audits

Road safety audits are addressed specifically under the "safer roads" objective in the Road Safety 2000 Strategic Plan. The plan states that the process of safety audits, which is applicable to all roads in NSW, will ensure that safety aspects are properly addressed in all development activities.

Road safety audits began in NSW in 1990. In mid-1991, RTA developed a road safety audit manual. Road safety audits are sold as part of the overall quality management

approach in the state—the emphasis is on safety in all aspects of a project. Each year 20 percent of the existing roadways in each region are audited, and approximately 20 other design audits are conducted. The goal was to cover the entire state roadway network in five years.

2.4 New Zealand

New Zealand is about the size of Colorado and has a population of 3.5 million. The majority of the population is concentrated in the northern of two major islands; most people live in the cities of Auckland and Wellington, which is the capital. There are only two levels of government: national and local. The roadway network consists of 10,400 km of roadways, fully funded by the federal government, and 85,000 km of local roads. In fiscal year 1996-97, the government committed NZ$743.7 million (US$580 million) to the National Roadway Programme (NRP).

In 1989, the government underwent massive reorganization, based on a commitment to quality concepts and privatization of government functions. The State Sector Act of 1988 provided for the reorganization of government into "crown agencies." Crown agencies are government corporations headed by chief executives responsible to Crown Authorities. There are six crown entities that report to the Minister of Transport. They are

- Civil Aviation Authority,
- Maritime Safety Authority,
- Land Transport Safety Authority,
- Transfund New Zealand,
- Transit New Zealand, and
- Transport Accident Investigation Commission.

Each authority operates like a corporate board, is an independent body appointed by the government, and is directly responsible to the Minister of Transport. As a result of the change in focus and the reassigning of duties, the Ministry of Transport was downsized from 6,000 people to 50. With the restructuring, the focus shifted from operations to policy and regulations. Decisions are driven by benefit/cost analysis on a project-by-project basis.

2.4.1 Management of Road Safety

The primary agencies responsible for road safety in New Zealand are as follows:

- Ministry of Transport is responsible for provision of overall policy advice to the Minister, in addition to legislation and long-term strategy development.
- Land Transport Safety Authority (LTSA) is responsible for establishing standards for entry to the system and monitoring adherence to them, reviewing the land transport system, and investigating crashes. It is also responsible for managing the Safety (Administration) Programme (S(A)P).
- New Zealand Police is responsible for traffic law enforcement, driver testing, and heavy-vehicle regulation enforcement.
- Transit New Zealand (TNZ) is responsible for managing the highway network.

- Transfund New Zealand is responsible for the allocation of monies from the National Roads Account to road and other agencies to achieve a safe and efficient road system.

Funding for safety programs is provided through two main mechanisms: the S(A)P and the NRP. (The NRP was formerly referred to as the National Land Transport Programme.) The S(A)P is managed by the LTSA and funds police road safety programs, community projects, and LTSA. NRP is administered by Transfund New Zealand, which funds road maintenance and construction on highways and provides financial support to local authorities.

At the national level, there are several bodies that coordinate safety. The National Road Safety Committee is composed of the chief executives of the national government agencies involved in road safety, and the National Road Safety Advisory Group includes representation from many national agencies and organizations interested in road safety. At the local level, regional councils are responsible for developing the 14 Regional Land Transport Strategies that include safety components.

As mentioned earlier, LTSA administers the S(A)P, which concentrates on regulatory and behavioral issues. The program includes more than NZ$25 million (US$18.25 million) for dissemination of safety information, monitoring safety activities, and auditing commercial vehicle fleets. These audits, known as performance audits, are evaluations of the functions and services delivered, and are not road safety audits. The S(A)P also includes about NZ$188 million (US$137.24 million) for police activities.

New Zealand has a National Road Safety Plan that was instituted in 1990 and revised in 1995. It is administered by the National Safety Road Advisory Group and includes a safer roads priority area, of which road safety audits are a component. Safety audits are identified as a policy and procedure of TNZ.

2.4.2 Road Safety Audits

Road safety audits were introduced in New Zealand in 1990. In 1993, TNZ published "Safety Audit Policy and Procedures," which stated that all projects costing over NZ$5 million (US$3.65 million) would be audited at all stages—feasibility, preliminary design, detailed design, and pre-opening of project development. Smaller projects are only audited at later stages. TNZ implements the policy based on a 20-percent sample of highways, but has no guidelines as to which highways should be included in the sample. Funding for the safety audit program is provided by Transfund.

3.0 CHECKLIST OVERVIEW

Safety audit procedures are based on a series of checklists. Checklists were first developed and used in the United Kingdom and are an aid to conducting safety audits. Checklists have been prepared for each of the five stages of safety audits:

Stage 1: Feasibility

Stage 2: Draft Design or Project Assessment

Stage 3: Detailed Design or Final Design

Stage 4: Pre-Opening

Stage 5: Existing Roads

Within each stage, separate checklists are used to evaluate a number of elements and features. While both New Zealand (*Safety Audit Policy and Procedures*, Transit New Zealand, 1993) and New South Wales (*Road Safety Audits*, RTA, 1995) have safety audit procedure manuals, the process for each jurisdiction is similar to the one described in the Austroads guide.

Following are examples of the checklists that are used in practice. The master checklist was developed by TNZ for Stages 1 to 4 and identifies all the items that are covered by the forms. Excerpts from the New Zealand manual for a Stage 1 audit are included. Samples from the New South Wales manual for a Stage 2 audit, and from the Austroads Guide for some of the elements of a Stage 4 audit, are also reproduced.

It is important to note that use of the checklists is not intended to replace professional judgment in the conduct of an audit. The checklists provide an excellent structure for performing the audit, but the safety of additional features must be evaluated.

3.1 Sample Checklists from Transit New Zealand: MASTER and STAGE 1

Excerpts are reprinted with permission from Transit and Transfund New Zealand.

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MASTER CHECK LIST - ALL STAGES

STAGE 1-FEASIBILITY ("F")	STAGE 2 - PROJECT ASSESSMENT ("P")	STAGE 3 - FINAL DESIGN ("D")	STAGE 4 - PRE-OPENING ("O")
F1a General Topics: 1. Scope of Project, function, traffic mix 2. Type and degree of Access to Property and Developments 3. Significant adjacent Developments 4. Influence of staging 5. Future widening &/or Realignments 6. Wider network effects	**P1a. General Topics:** 1. Changes since Stage 1 2. Drainage 3. Climatic Conditions 4. Landscaping 5. Services 5. Access to Property and Development 7. Emergency vehicles and Access 8. Future widening &/or Realignments 9. Staging of scheme 10. Staging of works 11 Significant adjacent Developments 12. Stability of cut & fill - surface effects	**D1a General Topics:** 1. Changes since Stage 2 2. Drainage 3. Climatic Conditions 4. Landscaping 5. Services. 6. Access to Property and Development 7. Emergency vehicles and Access 8. Future widening &/or Realignments 9. Staging of scheme 10. Staging of works 11. Significant adjacent Developments 12. Batter stability - surface effects	**O1a. General Topics:** 1. Changes since Stage 3 & Transition of Design 2. Drainage 3. Climatic Conditions 4. Landscaping 5. Services 6. Access to Property 7. Emergency vehicles & Access 11. Significant adjacent Developments 12. Batter Treatment 17. Shoulders & edge delin. 20. Signs and markings 21. Surface, skid resistance 22. Contrast with markings 23. Installed hazards 24. Natural features
F1b Design Approach 7. Route Choice 8. Impact of continuity with existing network 9. Broad design standard 10. Design speed 11. Design Volume, traffic characteristic	**P1b Design approach** 13. Geometry of horizontal and Vertical Alignment 14. Typical Cross Sections 15. Effect of Cross Sectional Variation 16.Roadway Layout 17. Shoulders and edge treatment 18. Effect of Departure from Standards & guidelines	**D1b Design Approach** 13 Geometry of horizontal and Vertical Alignment 14. Typical Cross Sections 15. Effect of Cross Sectional Variation 16. Roadway Layout 17. Shoulders, edge treatment 18. Effect of Departure from Standards & guidelines 19. Visibility, sight distances 20. Signs and markings	
F2 Intersections 1. Number and Type of Intersections	**P2 Local Alignment** 1. Visibility 2. Layout, including appropriateness of type 3. Readability by drivers	**D2 Local Alignment** 1. Visibility 2. New/Existing Road Interface 3. Readability by drivers 4. Detailed Geometric Design 5. Treatment - bridges & culverts	**O2. Local Alignment** 1. Visibility, sight distances 2. New/Existing Road Interface 3. Readability by drivers 5. Treatment at Bridges and Culverts
F3. Environmental Constraints 1. Safety Aspects, including weather, natural features	**P3. Intersections** 1. Visibility 2. Layout, including appropriateness of type 3. Readability by drivers	**D3. Intersections** 1. Visibility 2. New/Existing Road Interface 3. Readability by drivers 4. Detailed Geometric Design 5. Traffic signals 6. Roundabouts, islands 7. Other intersections	**O3. Intersections** 1. Visibility 3. Readability by drivers 5. Traffic Signals 6. Roundabouts, islands
F4. Any Matter not covered above 1. Safety aspects not already dealt with	**P4. Non-Vehicular provision** 1. Adjacent Land 2. Pedestrians 3. Cyclists 4. Equestrians/stock	**P4. Non-Vehicular provision** 1. Adjacent Land 2. Pedestrians 3. Cyclists 4. Equestrians/stock	**O4. Non-vehicular provision** 1. Adjacent Land 2. Pedestrians, incl. refuges 3. Cyclists 4. Equestrians/stock
	P5 (6). Signs and Lighting 1. Lighting 2. Signs 3. Markers, edge delineation	**D5. Signs and Lighting** 1. Lighting 2. Signs 3. Markers, edge delineation	**O5. Signs and Lighting** 1. Lighting 2. Signs, visibility & position 3. Markers, edge delineation
		D6. Physical Objects (poles, barriers, etc.) 1. Median barriers 2. Poles & other obstructions 3. Guardrailing 4. Bridge & culvert parapets	**O6. Physical Objects (poles, barriers, etc.)** 1. Median Barriers 2. Poles & other obstructions 3. Guardrailing
Note: This stage is the only checklist not to conform with the standard sequential numbering and topic descriptions. All subsequent safety audit checklists have a standard format and text	**P7. Construction and Operation** 1. Buildability 2. Operation 3. Traffic Management 4. Network Management 5. By - law requirements	**D7. Construction and Operation** 1. Buildability 2. Operation 3. Traffic Management 4. Network Management 5. Temporary traffic control / management	**O7. Construction and Operation** 2. Operation 3. Traffic Management in pract 6. Temporary Traffic Control/ Management, change to permanent
The narrow columns are for the use of Safety Auditors in any way they see fit.	**P8. Any other matter** 1. Safety aspects not already covered	**D8. Any other matter** 1. Safety aspects not already covered	**O8. Any other matter** 1. Safety aspects not already covered

F

STAGE 1 - FEASIBILITY ("F")

Reference	TOPIC	No.	ITEM
F1a	General Topics: Broad issues to be addressed	1	Scope of Project, function, traffic mix
		2	Type and degree of Access to Property and Developments
		3	Significant adjacent Developments
		4	Influence of staging
		5	Future widening &/or Realignments
		6	Wider Network effect
F1b	General Topics: Design approach	7	Route Choice
		8	Impact of continuity with existing network
		9	Broad design standard aimed at
		10	Design speed
		11	Design Volume, traffic characteristics
F2	Intersections	1	Number and Type of Intersections
F3	Environmental Constraints	1	Safety Aspects, including weather, natural features
F4	Any Matter not covered above	1	Safety aspects not already dealt with

Note: This is the only checklist not to conform with the standard sequential numbering and topic descriptions. All subsequent safety audit checklists have standard format and text.

F1a

STAGE 1 - FEASIBILITY ("F")

Check list F1a: General Topics: Broad Issues to be Addressed

ITEM	ISSUES TO BE CONSIDERED	CHECK
1 Scope of Project Function Traffic Mix	A broad appreciation of the scope of the project will assist in addressing topics further on in this check list. What is the general type of project for which the design has been carried e.g: Motorway or major arterial, or simply a minor improvement? Is the road intended to carry high speed traffic or possibly serve local access needs only? What kind of traffic is to be carried, ranging from high speed mixed traffic (i.e. including a significant number of heavy goods vehicles) or for more general use including for instance, cycles and significant pedestrian foot traffic?	
2 Type and degree of accessed property and developments	Check the general layout of the scheme, including (a) Questions of visibility and speed, related to the number and type of intersections and accesses to property alongside. (b) Check the width of the right of way, or the detailed design within that width, as affected by access requirements.	
3 Significant adjacent developments	Check major generators of traffic, including housing or shopping centres, that may have a significant influence on the form of the design. Check for distance of accesses from intersections and visibility of and from accesses to significant traffic generators.	

Continued...

F1a contd.

STAGE 1 - FEASIBILITY ("F")

Check List F1a : General Topics: Broad Issues to be Addressed - contd.

ITEM	ISSUES TO BE CONSIDERED	CHECK
4 Influence of staging	Check the design against staging requirements. Will this scheme be one stage of several? Will future schemes be either linear extensions of the scheme, or will possible redundancies be caused by widening?	
5 Future widening and/or realignments	What is the likelihood of (a) Future widening? (b) The addition of a complete second carriageway? (c) Later realignments? (d) Introductions of major geometric changes at intersections?	
6 Wider network effects	Are there any harmful or beneficial safety aspects within the proposed project or on the surrounding network?	

F1b

STAGE 1 - FEASIBILITY ("F")

Check list F1b : General Topics: Design Approach

ITEM	ISSUES TO BE CONSIDERED	CHECK
7 Route Choice	Consider the broad concept involved in the choice of a route or alignment Does the route follow existing roads or is it a "Green fields Project" and what are the effects of this? Does the scheme fit in with the physical constraints of the landscape and major network considerations?	
8 Impact of continuity with the existing network	Check for potential problems where the proposed roading scheme blends with or adjoins the existing network.	
9 Broad design standard aimed at	Check that the appropriate design standards have been used having regard to the scope of the project, its function in relation to the traffic mix.	
10 The design speed	Check the design speed for horizontal and vertical alignment, visibility, merging, weaving, and decelerating or accelerating traffic at controlled intersections. Check the effects of sudden changes in the speed regime or posted speed limit. Check the appropriateness of both the design speed and designated speed limit, if any, on the proposed roading project.	
11 Design volume traffic characteristics	Check the appropriateness of the design for the volume and traffic characteristics (including the effects of unusual proportions of heavy vehicles, cyclists and pedestrians, or side friction effects). Check the possible effects of unforeseen or large increases in traffic volume or changes in the traffic characteristics.	

STAGE 1 - FEASIBILITY ("F")

Check List F2: Intersections

ITEM	ISSUES TO BE CONSIDERED	CHECK
1 Number and type of intersections	Check the appropriateness of intersections with respect to the broad concept of the project, its function and traffic mix and also the need to serve intersecting roads appropriately to their function. Check the number and type of intersections, including the relationship both of spacing and type of one intersection with another. Are there any traffic or safety aspects of the scheme or of the traffic in the area which would favour or disfavour any particular layout? Are there any physical or visibility constraints which would influence the choice or spacing of intersections? Are all of the proposed intersections necessary or essential, or can the surrounding network be modified beneficially? Does the vertical, geometry or horizontal alignment have any influence on the style or spacing of inter-sections?	

Check List F3 - Environmental Constraints

ITEM	ISSUES TO BE CONSIDERED	CHECK
1 Safety aspects, including weather and natural features	Check the surrounding terrain for physical or vegetation defects which could affect the safety of the scheme - for instance, heavy planting or forestry, deep cuttings, physical features such as steep or rocky bluffs which constrain design. Check the scheme for the effects of wind. Check for the effects of mist or ice. Do the gradients, curves and general design approach fit in with the likely weather or environmental aspects of the terrain?	

F4

STAGE 1 - FEASIBILITY ("F")

Check List F4: Any Matter Not Covered Above

ITEM	ISSUES TO BE CONSIDERED	CHECK
1 Safety aspects not already dealt with	Check any aspects which do not readily fall into any of the above categories. E.g.: (a) The absence of electric power limiting the form of warning notices, (b) Flooding, (c) Moving stock, (d) The country may be unstable, (e) Low flying aircraft or advertising could be distracting to drivers. (f) Laybys or parking may be needed (e.g. for tourist routes, picnic or rest areas). (g) The potential of the route to attract roadside stalls, (h) Special events creating unusual or hazardous conditions, (i) Any other matter which may have a bearing on safety.	

3.2 Sample Checklist from Roads and Traffic Authority: STAGE 2

Excerpts are reprinted with permission from the Roads and Traffic Authority of New South Wales.

	N/A	Yes	No	Comments
STAGE 2: DRAFT DESIGN At this stage, issues like intersection or interchange layout and the chosen design standards are addressed. Where land acquisition is required, the draft design stage audit is undertaken before title boundaries are finalised. It should be noted that the auditor may not be able to answer some questions at this point. Where the question cannot be given a 'Yes' due to lack of detail at this stage, it should be answered 'No' with the comment simply indicating that the auditor cannot determine that issue at this stage. **2.1 GENERAL TOPICS** **1 Changes Since Stage 1 (Feasibility)** 1A Do the conditions for which the route was originally designed still apply? (ie. there have not been significant changes to the surrounding network or area to be served or traffic mix.) 1B Has the project design remained unchanged, in principle, since a Stage 1 audit (if any) was carried out? **2 Drainage** 2A Will the new road drain adequately? 2B Has the possibility of surface flooding been adequately addressed, including overflow from surrounding or intersecting drains and water courses? **3 Climatic Conditions** 3A Has consideration been given to weather records or local experience which may indicate a particular problem? (eg., snow, ice, wind, fog). **4 Landscaping** 4A Has safety been adequately considered in the landscaping design or planting? (eg. Will road traffic see pedestrians and vice versa; etc). 4B Has safety been adequately considered for when vegetation is mature or growth is seasonal (eg. through loss of visibility, obscuring signs, shading or light effects, leaves, flowers or seeds dropping onto the highway)? 4C Has the use of "frangible" vegetation been considered?				

		N/A	Yes	No	Comments
2.1	**GENERAL TOPICS (contd.)**				
5	**Services**				
	5A Does the design adequately deal with buried and overhead services (especially in regard to overhead clearances)?				
	5B Has the location of fixed objects or furniture associated with services been checked, including the position of poles?				
6	**Access to Property and Developments**				
	6A Can all accesses be used safely? (entry and exit/merging).				
	6B Is the design free of any down-stream or upstream effects from accesses, particularly near intersections?				
	6C Have rest areas and truck parking accesses been checked for adequate sight distances, etc.?				
7	**Emergency Vehicles and Access**				
	7A Has provision been made for safe access and movements by emergency vehicles?				
	7B Does the positioning of medians and vehicle barriers allow emergency vehicles to stop & turn without unnecessarily disrupting traffic?				
8	**Future Widening and/or Realignment**				
	8A If the scheme is only a stag towards a wider or dual carriageway: - is the design adequate to impart this message to drivers? - is the signing adequate to impart this message to drivers?				
	8B Is the transition from single to dual carriageway handled safely?				
	8C Is the transition from dual carriageway to single carriageway handled safely? (this is especially important in transition from freeway to 2 lane-2 way highway.)				
9	**Staging the Scheme**				
	If the scheme is to be staged or constructed at different times: 9A Are the construction plans and program arranged to ensure maximum safety?				
	9B Do they include specific safety measures for any temporary arrangements? (eg. signing; adequate transitional geometry; etc.).				

		N/A	Yes	No	Comments
2.1	**GENERAL TOPICS (contd.)**				
10	**Staging of the Works**				
10A	If the construction is to be split into several contracts, have each of these been arranged for maximum safety?				
11	**Adjacent Developments**				
11A	Does the design handle accesses to major adjacent generators of traffic and developments safely?				
11B	Is the driver's perception of the road ahead free of adverse effects of lighting and/or traffic signals on adjacent roads?				
12	**Stability of Cut and Fill**				
12A	Has a satisfactory report on the geological stability of the country through which the road is to be constructed (and resulting cut and fill) been completed?				
13	**Maintenance**				
13A	Can maintenance vehicles be safely located?				

		N/A	Yes	No	Comments
STAGE 2: DRAFT DESIGN					
2.2	**DESIGN ISSUES (GENERAL)**				
1	**Geometry of Horizontal and Vertical Alignment**				
	1A Does the horizontal and vertical design combination of the road provide a suitable alignment for drivers?				
	1B Do the combinations of horizontal and vertical design elements conform to design practice? (ie. there shouldn't be undesirable combinations of horizontal and vertical design)				
	1C Is the design free of cues that would cause a driver to misread the road characteristics? (eg. visual illusions, subliminal delineation such as lines of trees, poles, etc.)				
	1D Does the alignment selected ensure speed consistency?				
	1E Are overtaking / climbing criteria met?				
2	**Typical Cross Sections**				
	2A Are the lane widths, shoulders, medians and other cross section features in accordance with standard design and adequate for the function of the road?				
	2B Is the width of traffic lanes and carriageway suitable in relation to: - alignment? - traffic? - vehicle dimensions? - speed environment? - combinations of speed and traffic volume?				
3	**The Effect of Cross Sectional Variation**				
	3A Is the design free of variations in cross section design that may have an adverse affect on road safety?				
	3B Are crossfalls safe? (particularly where sections of existing highway have been utilised or there have been compromises to accommodate accesses, etc.)				
	3C Are crossfalls safe where compromises have been made such as narrowing at bridge approaches or to avoid physical features?				

		N/A	Yes	No	Comments
2.2	**DESIGN ISSUES (GENERAL) (contd.)**				
4	**Roadway layout**				
	4A Are all traffic management features (in addition to horizontal and vertical alignment and cross section) designed so as to avoid creating unsafe conditions?				
	4B Is the layout of road markings and reflective media (both on the road and on the surrounds) able to deal satisfactorily with changes in alignment? (particularly where the alignment may be substandard.)				
5	**Design Standards**				
	5A Has the design speed been selected in keeping with the terrain and importance of the road?				
	5B Is the design speed commensurate with the intended speed limit?				
6	**Shoulders and Edge Treatment**				
	6A Are the following safety aspects of shoulder provision satisfactory: - provision of sealed or unsealed shoulders? - width and treatment on embankments? - cross fall of shoulders?				
	6B Are the shoulders likely to be safe if used by slow moving vehicles or cyclists?				
	6C Have the safety aspects of rest areas and truck parking areas been checked in regard to shoulders?				
7	**Effect of Departures from Standards or Guidelines**				
	7A Are there any approved departures from standards which affect safety?				
	7B Have all hitherto undetected departures from standards been brought to the attention of the designer?				

			N/A	Yes	No	Comments
	STAGE 2: DRAFT DESIGN					
2.3	**ALIGNMENT DETAILS**					
1	**Visibility; Sight Distance**					
	1A	Are horizontal and vertical alignments consistent with the visibility requirements?				
	1B	Will the design be free of sight line obstructions due to: - Safety fences? - Boundary fences? - Street furniture? - Parking facilities? - Signs? - Landscaping? - Bridge abutments? - parked vehicles in laybys? - parked or queued traffic?				
	1C	Are railway crossings, bridges and other hazards all conspicuous?				
	1D	Is the design free of any other local features which may affect visibility?				
2	**New/Existing Road Interface**					
	2A	Have implications for safety at the interface been considered? (Include the accident rate and severity on the adjacent network, and the effect of sudden changes in the speed regime, or access, or side friction characteristics.)				
	2B	Does the interface occur well away from any hazard? (eg. a crest, bend or where poor visibility/ distractions may occur.)				
	2C	Is the change affected safely at any location where carriageway standards differ?				
	2D	Are transitions where the road environment changes safe? (eg. urban to rural; restricted to unrestricted; lit to unlit.)				
	2E	Has the need for advance warning been considered?				
3	**'Readability' for the alignment by drivers**					
	3A	Will the general layout, function and broad features be recognised by drivers in sufficient time?				
	3B	Are the approach speeds and general likely positions of vehicles as they track through the scheme satisfactory?				

			N/A	Yes	No	Comments
STAGE 2: DRAFT DESIGN						
2.4	**INTERSECTIONS**					
1	**Visibility to and visibility at intersections**					
	1A	Are horizontal and vertical alignments at the intersection or on the approaches to the intersection consistent with the visibility requirements?				
	1B	Will drivers be aware of the presence of the intersection?				
	1C	Will the design be free of sight line obstructions due to:				
		- Safety fences?				
		- Boundary fences?				
		- Street furniture?				
		- Parking facilities?				
		- Signs?				
		- Landscaping?				
		- Bridge abutments?				
	1D	Are railway crossings, bridges and other hazards all conspicuous?				
	1E	Will the design be free of any local features which adversely affect visibility?				
	1F	Will sight lines be unobstructed by permanent or temporary features such as parked vehicles in laybys, or by parked or queued traffic generally?				

			N/A	Yes	No	Comments
2.4	**INTERSECTIONS (contd.)**					
2	**Layout, including the appropriateness of type**					
	2A	Is the type of intersection selected (cross roads, T, roundabout, signalised, etc) appropriate for the function of the two roads?				
	2B	Are the proposed controls (Stop, Give Way, Signals, etc.) appropriate for the particular intersection being considered?				
	2C	Are junction sizes appropriate for all vehicle movements?				
	2D	Are the intersections free of any unusual features which could affect road safety?				
	2E	Are the lane widths and swept paths adequate for all vehicles?				
	2F	Is the design free of any upstream or downstream geometric features which could affect safety? (eg. merging of lanes.)				
	2G	Have public transport facilities been catered for?				
	2H	Are the approach speeds commensurate with the intersection design?				
	2I	Where a roundabout is proposed:				
		- have pedal cycle movements been considered?				
		- have pedestrian movements been considered?				
		- are details regarding the circulating carriageway sufficient?				
3	**Readability by Drivers**					
	3A	Will the general layout, function and broad features be perceived by drivers adequately?				
	3B	Are the approach speeds and general likely positions of vehicles as they track through the scheme satisfactory?				
	3C	Is the design free of sunrise or sunset problems which may create a hazard for motorists?				

3.3 Sample Checklist from Austroads: STAGE 4

Excerpts are reprinted from *Road Safety Audit*, Austroads, 1994.

Stage 4
Pre-opening

Checklist **4.1**

General Topics

Project _____

Audited by _____

Date _____

Item	Issues to be Considered	Check	Comments
1 Changes since Stage 3 and translation of design into practice	Carry out a general check -- particularly for matters changed at previous audits.		
	Check the translation of the design into its physical form and any changes that could affect safety.		
2 Drainage	Check drainage of road and surrounds is adequate.		
3 Climatic conditions	Check effectiveness of any facilities put in place to counter climatic conditions.		
4 Landscaping	Check that planting and species selection is appropriate from safety point of view.		
5 Services	Check that boxes, pillars, posts and lighting columns are located in safe positions.		
	Are they of appropriate materials or design?		
6 Access to property and developments	Check that accesses are safe for intended use.		
	Check on adequacy of design, location and visibility in particular.		
7 Emergency vehicles and access	Check that provision for emergency vehicle access and stopping is safe.		
8 Significant adjacent developments	Check effectiveness of screening of adjacent developments and other special features.		
9 Batter treatment	Check that batter treatment will prevent or limit debris falling on to the carriageway.		
10 Shoulders and edge delineation	Check that all delineators and pavement markings are correctly in place.		

Item	Issues to be Considered	Check	Comments
11 Signs and markings	Check that all signs and pavement markings are correctly in place. Check that the appropriate sign has been used (especially Chevron Alignment Markers).		
	Check that they will remain visible at all times. Check that old delineation (signs, markings) have been removed and are not liable to confuse.		
12 Surface treatment, skid resistance	Check all joints in surfacing for excessive bleeding or low skid resistance.		
	Check all trafficked areas for similar problems, including loose stones.		
13 Contrast with markings	Check that the road markings as installed have sufficient contrast with the surfacing and are clear of debris.		
14 Roadside hazards	Check that no roadside hazard has been installed or overlooked.		
15 Natural features	Check that no natural feature (e.g., a bank rock or major tree) creates danger by its presence or loss of visibility.		

Stage 4
Pre-opening

Checklist **4.2**

Alignment Details

Item	Issues to be Considered	Check	Comments
1 Visibility, sight distances	Check that sight lines are not obstructed.		
2 New/existing road interface	Check the need for additional signs and/or markings.		
3 Readability by drivers	Check that the form and function of the road and its traffic management are easily recognised under likely operating conditions (e.g. under heavy traffic or poor visibility conditions).		
	Check transition between old and new alignment, that the road is 'readable' and does not create uncertainty at the point of transition.		
4 Treatment at bridges and culverts	Check that all markings and signs are in place and readable.		

Project _____

Audited by _____

Date _____

Stage 4
Pre-opening

Checklist **4.3**

Intersections

Item	Issues to be Considered	Check	Comments
1 Visibility of intersection	Are drivers aware of the presence of the intersection (especially if facing a Stop/Give Way sign)?		
2 Visibility at intersection	Check that all visibility splays or parts of the right of way required for visibility are clear for cars, trucks and vehicles with restricted visibility (e.g. vans, cars towing caravans).		
3 Readability by drivers	Check by driving each approach that the form and function of the intersection is clear to all drivers.		
	Check that the stop/give way line is clear, and that the driver is given sufficient cues to stop before protruding into conflicting traffic.		
4 Traffic signals	Check alignment and general correctness of installation and that all aspects are visible from each approach lane at the appropriate distances.		
	Check the safe operation of signals and associated equipment for all road users.		
	Check markings for right turning vehicles.		
5 Roundabouts and approach islands	Check that the roundabout or island is fully visible and recognisable from all approaches and that signs, markings and lighting are correctly in place.		

Project

Audited by

Date

still be required and therefore result in the same termination difficulties. Localised leveling or a SENTRE should satisfy the termination requirements.

(e) Kerb and channel are shown at all locations along the Western Ring Road, collector distributor road and the ramps. Kerb and channel have the potential to cause overturning of errant vehicles on high speed roads, especially when the errant vehicle leaves the carriageway in the no tracking mode. (50% of all loss of control accidents are in the no tracking mode). **Consideration should be given to removing all kerb and channel, especially on the high side of the pavement as they are not considered to be necessary for drainage.** The semi-mountable profile along the low side of the pavement should be replaced with fully mountable kerbs to minimise the effects of destabilisation or the risk of overturning of an errant vehicle. Kerb and channel will also interfere with the performance of impact attenuators such as the G.R.E.A.T.

(f) Pavement drains should be located directly underneath kerb and channel rather than behind it as shown in the drawings. Pavement drainage along the proposed location will interfere with the installation of guard fence should it be needed in the future.

(g) It is considered to be acceptable to vary the ramp shoulder width from 3.0m to 2.5m provided that there is no vertical wall or safety barrier along the edge of shoulder. However, the shoulder width must be at least 3.0m at the taper as proposed. The minimum pavement width including shoulders is 8.0m on looped ramps (refer *Road Design Note 5-7*) to allow for tracking of large vehicles and passing of slow or broken down vehicles.

(h) The typical freeway cross section between chainages CH 420 to CH 620 indicates shoulder widths of 2.5m. Such a shoulder width does not satisfy the current freeway standards. Furthermore, the 2.5m shoulder is inadequate to sufficiently store a broken down vehicle clear from the though lanes. This is more of a problem in the location where New Jersey barrier is proposed along the edge of the shoulder as it does not allow adequate width to open the passenger side door, nor does it allow sufficient width for the driver's side door to be swung open without encroaching into the through lanes. It is suggested that the verge be reduced to create a 3m shoulder. The 2.5m shoulder width is not as critical where the kerb can be mounted to enable the vehicle to pull clear of the through lane. However, 3m shoulder is preferable and should be provided where possible.

(i) The typical cross section for Western Ring Road between chainages CH 280 to CH 420 shows kerb and channel along the existing westbound carriageway. The presence of kerb and channel will severely affect the performance of New Jersey barrier and therefore the kerb and channel should be removed. The area between the kerb and New Jersey barrier is also not shown to be paved. It is

critical to ensure that the area is paved to minimise the risk of overturning during impact. The offset of the proposed New Jersey barrier from the existing westbound carriageway is unclear from the plans. The offset should not exceed 5m from either carriageway, as beyond this offset steeper impact angles can be experienced. Some adjustment to the proposed location of the New Jersey barrier may therefore be required.

(j) At low fill heights it is considered incorrect to specify batter slopes, especially 3:1 or steeper, as it results in unnecessarily steep batters and it is also unrealistic in practice. It would be safer from a road safety perspective to allow the fill batter to blend into the natural surface which would also be consistent with construction practice.

(k) The longitudinal sections should show all nose locations to enable checking of sight distance requirements.

5.2 Specific Comments

5.2.1 Western Ring Road

CH390 to CH 410 (ref 88591500)

These cross sections indicate steep fill batters (2:1, 2.5:1, etc.) along the freeway. Such batter slopes are not acceptable and should be made gentler to no steeper than 4:1. The plans do not show safety barrier (not the preferred option) which would then enable the batter slopes to remain as proposed.

5.2.2 Collector Distributor Road

(a) CH 00 to CH 130 (ref 88592500 - 88592503)
The separation between carriageways does not appear to be adequate. If New Jersey barrier is proposed, then there is a need to pull out the kerb and adjust the slope on the approach. The kerb and channel will interfere with the performance of the G.R.E.A.T unit at CH 130 (gore area).

(b) CH160 (ref 88592504)
The fill batter along the fast lane does not appear to be correct. Check to ensure such batter slopes are not present along the carriageway.

(c) CH 460 to CH 680 (ref 88592509 to 88592513)
Fill batter slope proposed is not advisable. The batter should be at least 4:1 with a 1m verge rounding or desirably at 6:1. The batter slope should be at least 6:1 if traffic analysis indicates a high percentage of commercial vehicle usage. It is assumed that this road will carry a high volume of commercial traffic. If there is inadequate reservation width to achieve a gentler slope, a 'barn roof' batter profile could be considered.

4.0 SAMPLE ROAD SAFETY AUDITS

Following are excerpts from reports on three actual road safety audits performed in Victoria, New South Wales, and New Zealand.

The first is a Stage 2: Functional Design audit performed by a consultant for an interchange outside of Melbourne, Victoria. The second is a Stage 4: Pre-Opening audit for a major new bridge over an inlet to Sydney Harbor. The third is a Stage 3: Detailed Design audit for a proposed interchange on a commuter route in Wellington, New Zealand.

Collectively, the reports illustrate issues that are identified in the audits and the recommendations made at each stage of the process.

4.1 Sample Road Safety Audit: STAGE 2

Reprinted with permission from VicRoads and Road Safety Audits, Pty., Ltd.

TULLAMARINE FREEWAY / WESTERN RING ROAD INTERCHANGE
Functional Design
Road Safety Audit Report

1.0 INTRODUCTION

1.1 A road safety audit was conducted during the preliminary stages of the functional design for the Western Ring Road / Tullamarine Freeway Interchange.

1.2 This report documents the findings determined from the road safety audit.

1.3 The purpose of the audit is to highlight areas of concern from a safety perspective so that issues identified are reassessed by those who are carrying out the work. It needs to be appreciated that as the audit aims to assess works against the latest desirable road safety practices, some issues raised may go beyond the standards adopted for a particular project due to the time frame between planning and implementation. Whilst such an approach will therefore highlight deficiencies where designs have not been previously audited or standards have subsequently changed, the aim is to have corrective action taken where this is warranted and can be reasonably achieved.

1.4 The required response to the safety audit is set out in part 4.3, page 7 of the Road Safety Review Manual (applicable to VicRoads). The contractor is required to submit one copy of the road safety audit report with the proposed actions to address the deficiencies identified to VicRoads Western Ring Road Project office within 2 weeks of conducting the audit.

2.0 SUPPORTING MATERIAL TO FACILITATE AUDIT

The following material was provided:

- Alignment Plans
- Longitudinal sections
- Cross sections

3.0 AUDIT TEAM

The road safety audit on the fundtional design was conducted by :

Mr Raj Muthusamy, Principal Road Safety Auditor
and
Mr Manuel Pape, Senior Design Engineer

A closing meeting was held with Mr Eugene Golshtein from Ove Arup & Partners following the conduct of the audit.

4.0 DATE OF AUDIT

The road safety audit on the fundtional design was conducted on 2 October 1995 at the offices of Road Safety Audits Pty Ltd. The closing meeting was held on 3 October 1995 at the offices of Ove Arup & Partners.

5.0 AUDIT FINDINGS

Items of concern that were identified are listed below:

5.1 General Comments

The following general comments are made:

(a) 3:1 fill batters are proposed over significant lengths throughout the project. Such slopes are not preferable and should not be implemented as part of a new project. *Road Design Note 3-8* clearly indicates that the maximum slope on the left hand side of the carriageway should not exceed 4:1 and preferably 6:1 if a high volume of commercial vehicle usage is expected.

(b) 3:1 batter slope along ramps will also result in excessive lengths of guard fence, as the guard fence needs to be extended along the ramp to a point where the area in front and behind the terminal is 10:1 or gentler. Otherwise it does not satisfy requirements for safe termination as stated in *Road Design Note 3-8.*

(c) The other option is to consider installation of a SENTRE unit which is an acceptable terminal treatment to operate on slopes up to 1.5:1.

(d) The preferred option is to provide the slope at 4:1 or gentler, therefore guard fence is unlikely to be required. However, at higher batters guard fence would

(d) CH 280 to CH 400 (ref 885922505 to 885922508)
Approach slope (slope of separation between the existing westbound carriageway and the collector distributor road) to New Jersey barrier is too steep (steeper than pavement slope), and therefore is unacceptable. There should also be no kerb and channel present along the New Jersey barrier. The cross section also indicates that the New Jersey barrier is placed right on the edge of the constructed pavement. There should be at least 100m of constructed pavement beyond the back of the New Jersey barrier to minimise the potential for cracking of the pavement and to allow for deflections in the barrier system. Therefore the proposed barrier location may need to be adjusted slightly to create the additional pavement behind the New Jersey barrier. The use of a split profile New Jersey barrier should be considered to accommodate the level difference in the carriageways.

(e) CH 460 to CH 580 (ref 88592509 to 88592522)
Fill batter slope as proposed is not considered to be appropriate to minimise the risk of overturning errant vehicle. If road reservation does not allow the creation of a gentler batter over the total batter width, consideration should be given to creating a 'barn roof' batter profile.

(f) CH 760 to CH 860.664 (ref 88592516 to 88592520)
Fill batter slope proposed is unacceptable from a road safety perspective. In addition the cross section does not satisfy current standards. It is unclear from the cross sections whether this slope is to be protected using safety barrier. If safety barrier is proposed, it would be acceptable to have the steeper slopes.

5.2.3. Ramp F

(a) It is noted that the shoulder width along the ramp is only 2m. Such a width does not allow safe storage of a broken down vehicle. However, the presence of semi mountable kerb and verge will enable a vehicle to mount the kerb and pull clear of the through lane. Although the proposed shoulder width may be acceptable in this case it would still be preferable to provide 3m shoulders.

(b) CH 00 (ref 88593500)
The slope is considered to be too steep for height of the batter. A gentler batter slope should be adopted (4:1 or desirably 6:1).

(c) Over Majority of ramp
The proposed 3:1 fill batter slopes are considered to be inappropriate. These slopes should not be steeper than 4:1 where possible and there appears to be many areas where gentler batters can be achieved. Provision of fill batters at slopes of 3:1 are considered to be an unnecessary hazard.

(d) Ramp F merge into Tullamarine Freeway
Ensure that kerb and channel is not used between the ramp and the freeway (refer layout plan). Merging drivers may not expect kerb and channel to be present as they look behind their shoulder to merge into Tullamarine Freeway. It is suggested that kerb and channel (if still considered to be required throughout the project) be stopped as indicated in the layout plan and the ramp guidance be provided using line marking and RRPMs.

(e) The drainage should be checked to ensure that the surface flow at the low spot (under the bridge) is not deep enough to cause aquaplaning.

5.2.4 Ramp H

(a) CH 240 to CH 250 (Ref 88594506)
Cut batter slope between 3:1 and 2:1 is critical slope for overturning. Consideration should be given to creating a consistent safe cut batter slope of 3:1 over the total length of the cut.

(b) CH 280 to CH 310 (ref 88594508 to 88594509)
Majority of cut batter through the project are at 3:1 and is supported. There are however a number of sections where the cut batter slope is in the range between 2:1 and 3:1. Such batter slopes could be critical in contributing towards overturning of errant vehicles (especially small cars). Consideration should be given to making all cut batters to be at a consistent slope of 3:1.

(c) CH 280 to CH 766
The cut batter along the inside on the inside of the loop exceeds 1.1m in height and would therefore restrict sight distance to stationary vehicles at the merge with the collector distributor road (refer to layout plan). The area within the loop must be kept clear of vegetation and the batter should be kept well below 1m to ensure adequate sight distance is available.

(d) Grade line Ramp H (Ref 88594300)
The large vertical curve adopted on the approach to the collector distributor road should be replaced with a straight grade to match in with small vertical curve at the merge with the collector distributor road. Large vertical curves on approaches to intersections have the potential to restrict sight distance. The minimum sight distance available in the current design should be checked.

(e) The 0.06 m/m crossfall adopted at the loop is considered to be appropriate (0.07 m/m is preferable). A longer length along the straight approach should be used to develop to appropriate crossfall from 0.03 m/m to 0.06 m/m to minimise the risk of destabilising larger vehicles.

(f) CH 90 to CH 100 (Ref 88594501)
Hump adjacent to the existing southbound lane of Tullamarine Freeway should be removed. Position of ramp is not shown clearly in relation to existing pavement of Tullamarine Freeway.

(g) CH 330 to CH 350 (Ref 88594510)
The slope of separator between the ramp and the existing southbound carriageway of Tullamarine Freeway is considered to be too steep and unnecessary. Consideration should be given to maintaining the ramp at the same level as the Tullamarine Freeway until the ramp separates from the freeway alignment. The level difference could be removed via adjusting the ramp grade line. Although this measure is likely to result in a steeper grade towards the collector distributor road, it is considered to be acceptable, from a road safety perspective. Along an uphill grade on a loop due to the low speed that will be likely.

(h) The presence of the SEC pylons along the ramp is likely to require safety barrier irrespective of its location being outside the clear zone. The severity and consequences of the pylons being struck and brought down would warrant the installation of safety barrier.

(I) CH 330 to CH 380 (Ref 88594510 to 88594511)
There is no verge behind the kerb and channel. This measure is not advisable as it does no allow the opportunity for an errant vehicle to maintain tyre contact should they leave the carriageway. The provision of a verge and rounding will provide a better chance to maintain tyre contact which in turn will improve steerability and stopping. There is also reduced structural support for the kerb and channel due to the lack of verge to resist the forces applied when a vehicle mounts the kerb. These deficiencies support the move to consider lowering of the grade line along Ramp H as suggested in part(s) above.

(j) Bridge pier and abutment may interfere with sight distance for traffic approaching ramp H from Tullamarine Freeway. The bridge and abutment are not shown on the plans and therefore this criteria could not be assessed (refer to layout plan). The available sight distance should be checked.

(k) CH 400 to CH 430 (Ref 88594512)
The cut batter on the inside of the loop is over 1.5m in height and therefore will interfere with sight distance across the loop. The area within the loop should be clear to allow visibility across the loop to minimise the risk of rear end crashes (refer to layout plan).

5.2.5 Ramp A

Pavement crossfall on the collector distributor road should be steepened over a longer length on the lead into Ramp A. Other issues relevant to this location are raised in the layout plan.

5.2.6 Merge At Collector Distributor Road And Western Ring Road

Match-in point at the collector distributor road and WRR may not have sufficient sight distance due to VC in grade line of the Western Ring Road. The grade lines of the collector distributor road were not available for assessment. The designs should be checked to ensure minimum sight distance is available.

RAJ MUTHUSAMY
Principal Road Safety Auditor

4.2 Sample Road Safety Audit: STAGE 4

Excerpts are reprinted with permission from the Roads and Traffic Authority of New South Wales.

ROAD SAFETY AUDIT

Glebe Island Bridge and Approaches, Pyrmont

Pre-Opening Audit including Proposed Staged Traffic Arrangements

November 1995

1. INTRODUCTION

The new Glebe Island Bridge is scheduled to be opened to traffic on Monday, December 4 1995, following a number of pre opening functions including a community walk over the bridge on Sunday, December 31 1995.

Whilst the bridge itself is 99% complete, work on both eastern and western approaches is still being carried out and the traffic arrangements proposed for running traffic up onto and across the bridge on Monday 4 December, bear little resemblance to the ultimate arrangements scheduled to come into effect in March 1996.

Generally, the bridge will operate 4 lanes (2 in each direction) and as a necessity the existing section of Victoria Road, east of the ramp metering, will be slowed to allow completion of the east bound lanes approaching the western abutment of the new bridge. This work will necessitate a number of traffic switches to allow staging of the work.

Although this audit was intended to be undertaken as a Stage 4: Pre Opening audit it soon became obvious that such an audit at this time would not be possible due in part to the constrictive time constraints and the fact that a number of traffic management issues were still to be resolved. Moreover, it was decided by the audit team that a Stage 3 audit on the proposed traffic switches and arrangements up to and across the bridge combined with a safety appraisal of the work as completed at the time of the audit was more appropriate.

The audit team acknowledges the strict timetable governing this project and it is proposed that a further safety audit assessment of the project will be undertaken prior to the opening of the bridge in its ultimate traffic management configuration presently scheduled for March 1996.

Mindful of the abovementioned, the audit team did however identify a number of issues with which the project owners, Major Projects, are asked to consider, investigate and action. These issues are identified in the findings of the audit.

The RTA has a commitment to the application of quality assurance principles to a wide range of processes and activities. This includes the Road Safety Audit process. Major Projects, as project owners a formal response to the Road Safety Manager, in acknowledgment of the issues raised in the road safety audit report, including any proposed action, is required.

2. AUDIT TEAM

The Audit team consisted of the following personnel from the Road Safety and Traffic Management Directorate:

Fred Schnerring	Leader, Road Environment Strategy HO
Steve Levett	Project Officer, Road Environment Strategy HO
Ken Lysaught	Audit & Crash Investigation Leader, Road Safety Engineering, Sydney Region
Nick Phillips	Guidance Systems Leader, Traffic Flow (West) Sydney Region
Col Warne	Guidance Project Leader Traffic Flow (East) Sydney Region

PROJECT ADVISER

Alan Thomas	RTA Major Projects

3. ROAD SAFETY AUDIT PROCESS DETAILS

The scope of the audit comprises the examination of the proposed staging and traffic arrangements as indicated on **Plan Reg. No: 7000.412.CP.0003 Sheet 5 and Plan Reg. No: 7000.412.RD.0136 Phase 2;3;4.** for the bridge and its approaches from the ramp metering onto Victoria Road on the western side to the road works above the Gipps St intersection. These documents are attached as Appendix 1.

The audit was carried out during the morning and early afternoon of Tuesday 21 November 1995. Time constraints prevented a night-time audit.

The audit was carried out in accordance with the procedures set out in the RTA's Road Safety Audit manual, 2nd edition (1995). The Checklists for Stage 3 (Detailed Design) and Stage 4 (Pre-Opening) were used.

The purpose of the audit is to examine the accident potential and likely safety performance of the traffic arrangements and facilities to ensure a high level of safety for all road users.

A commencement meeting was with Mr Alan Thomas, who gave status report of the project to date and introduced the proposed plans for traffic management during the final works to connect the bridge to Victoria Road.

4. PROJECT DETAILS

Glebe Island Bridge is essentially an 8 lane structure, with 3 eastbound and 3 westbound lanes for general traffic, one eastbound transit lane and one shared pedestrian/cycle lane or path. A fixed barrier separates the shared pedestrian/ cycle lane from the other lanes.

An Elsholz Barrier Kerb divides the eastbound and westbound traffic streams. The Bridge connects to Victoria Road at its western end and to the Western Distributor at its eastern end. The Western Distributor is an elevated road system and a series of off-ramps connect the bridge and the distributor to the surface road system. The surface roads are under reconstruction as a result.

At the time of the audit, the final running surface had yet to be applied to the bridge, the connection with Victoria Road had yet to be made and some of the ramps at the western end had yet to be completed. Reconstruction of the surface roads to their ultimate configuration had not yet been completed (or started?).

5. FINDINGS OF THE AUDIT

5.1 Access to property and developments

Plans for access to the Fish Markets were not available.

Recommendation

Check plans when they become available for safe access/exit to Fish Markets.

5.2 Adjacent developments

The "pink panther" on top of Pink Panther Printing on the eastern end of the bridge is highly conspicuous and very likely to be more attention getting than any road signs installed nearby. Also, drivers' attention may also be diverted from concentrating on where the road goes (see also point 5.5). As a result vital driver information may not be read.

Recommendation

Screen the pink panther so that it cannot distract drivers' attention away from important road signs and the road alignment.

Additionally, it is suggested that the Authority support Local Government objections to large scale advertising installations intended to be read by bridge users.

5.3 Skid resistance

It is not known whether any special anti-skid surface is to be applied.

Given the combination of curves and grades at the eastern end and the downhill run into a sharpish curve at the western end, loss of control accidents could be expected in the wet as the skid resistance of the pavement diminishes.

Recommendation

Monitor skid resistance closely and maintain high skid resistance. Resurfacing at frequent intervals as necessary may be required to achieve this.

5.4 Horizontal and vertical alignment

(a) Eastern end

The alignment for eastbound motorists is very poor with the immediate alignment over the crest of the bridge disappearing from view, yet with the road still visible in the distance, off-line and to the right. Within this hidden area is a series of tight reverse curves which would require drivers to be travelling not greater than the signposted speed to negotiate safely. (Note that the pink panther mentioned above is located in the middle of these reverse curves and is visible, whereas the reverse curves

themselves are not.) Also, the approach downgrade to these curves from the west is in the area of 60%, which would tend to encourage drivers to speed down the grade. A speed limit of 70 km/h is proposed but current experience with the Sydney Harbour tunnel indicate that this speed limit would be generally exceeded at most times of the day.

The arc length of the middle curve of the three reverse curves is very short and when the curves do become visible to drivers, the middle one appears as a "kink", making it very hard to "read" and therefore hard to negotiate.

Recommendation
Provide very clear delineation through use of rrpms and CAMs and maintain at a high standard to maintain as much guidance as possible through this adverse alignment. (Screening of pink panther already recommended.)

Additionally, and with specific regard to horizontal and vertical alignment, it is recommended that the completed works be surveyed and checked to ensure that work as executed conforms with the intended design.

(b) Western end

The down grade on the western end is between 4%-6% and leads into a left curve tying into Victoria Road. Travelling west over the bridge the view is open and straight ahead and 7 lanes wide. The disguises the relative sharpness of the curve at bottom of the grade. With a 70 km/h speed limit, speed can be expected to be in the order of 80 km/h plus, which can easily be an inappropriate approach speed, especially in the wet to a curve which is hard to "read".

Recommendation
Provide 'B' size curve warning sign and curve alignment markers installed on New Jersey kerb for west bound traffic. Check curve for installation of advisory speed plates.

5.5 Sight distances

(a) Westbound on-ramp near the Fish Markets
Visibility to vehicles joining the bridge appears low. While the on-ramp continues into its own lane, drivers on the Western Distributor will see vehicles appear on the on-ramp quite quickly and may not appreciate that the on-ramp has its own lane. This may cause unnecessary slowing or braking in anticipation of a merge that will not happen.

Recommendation
Provide clear linemarking and signposting to indicate that the on-ramp is an added lane not a shared lane.

(b) Eastbound on-ramp at Gipps Street

This ramp was not inspected closely, but provides for the entry of traffic from the right on a left curve. Sight distance for entering traffic appears low. Lane arrangements are unknown, but any merging to the left while on a left hand curve and while reading advance warning signs for later lane positioning is a clear case of driver overload and an area where accident potential is considered high.

Recommendation

Ensure that a sufficiently long merge length is provided. Depending on down stream lane arrangements, provide the ramp with its own lane if possible.

5.6 Crossfall/superelevation and drainage

The three reverse curves on the alignment of each carriageway of the eastern approach to the new bridge could present a drainage problem, if the combination of grading and superelevation inadequately clears surface water from the pavement.

Recommendation

Check that the curves have been constructed with sufficient superelevation to ensure that the surface water drains off the pavement before it can be redirected back across the pavement by the change in grade and superelevation of the following curve. A pavement surface contour plan would show if the pavement can drain adequately to provide a safe travelling surface.

5.7 Bus bays

A bus bay for westbound buses is under construction on the western end of the bridge. Although sight distances are satisfactory, the location of the bus bay and its short length makes it difficult for buses to pull into and out of without disrupting through traffic in the kerbside lane which can be expected to be travelling at 70 to 80 km/h. The audit team acknowledge the need for the provision of this service and understand the service to be infrequent.

Recommendation

Reconsideration of the arrangements may be necessary if the frequency increases.

5.8 Delineation

The eastern approach to the bridge is along the Western Distributor. The Western distributor crosses Gipps Street on a left curving overpass. At this point 3 lanes merge into 2. Also, the three reverse curves mentioned above are not visible, although the main bridge deck is. It is suggested that drivers on the Gipps Street overpass will not be suspecting these reverse curves so closely after a lane merge.

Recommendation
The layout of the line marking and the exact location of the lane merge needs to be considered carefully so that all driver decisions are made clear and the approach into the "blind" reverse curves is as smooth as possible. Dropping the right lane half way over the overpass and then keeping the two through lanes as far left as possible on the overpass is offered as an option to address this issue.

5.9 Median barriers: General
There are three different barrier systems along the bridge and its approaches: An Elsholz barrier on the bridge deck; New Jersey barriers to be provided on the western and eastern approaches; and the twin overpasses at Gipps Street are to be provided with bridge rails forming an "internal" bridge rail barrier.

Recommendation
Ensure that all transitions between the different barrier types are detailed appropriately so that no launching or snagging of errant vehicles can occur.

5.10 Crash barriers
Details of crash barriers were not provided.

Recommendation
Ensure that GREATs or similar are provided at all gore areas; the western end of the New Jersey barrier on Victoria Road and around any isolated rigid structures such as bridge rail ends.

Note: Whilst considered a highly unlikely event it remains noteworthy that sections of the viaduct on the eastern end of the bridge are separated by gaps between the eastbound and westbound carriageways which will allow an errant vehicle to drop between them if the crash railing is breached for whatever reason.

5.11 Signposting Fish Markets access
While not considered strictly within the scope of the bridge safety audit it was noted that current access to the Fish Markets from Pyrmont Bridge Road is before the on-ramp to the bridge. This arrangement will be reversed when the final access to the Fish markets is provided. This means that traffic travelling north along Pyrmont Bridge Road will pass the Fish Markets before coming to the on-ramp, but access to the Fish Markets will be after the on-ramp.

Recommendation
Provide very clear signposting for access to the Fish Markets and the bridge to overcome the unexpected reversal of accesses.

5.12 Traffic management during construction

The City West Link's "metered" on-ramp was shown as having almost no merge length with Victoria Road. Given the limited sight distance, difference in levels and relatively parallel nature of the merge, safe merging of the two traffic streams would appear impossible without constant supervision and attention to driver information devices.

A number of traffic switches are planned to allow construction of the final tie in of Victoria Road with the bridge. If the plans are not followed closely and traffic provisions closely maintained, then clear guidance and control through the road works will be lost.

Recommendation

Maintain the bridge closure on 3 December for as long as possible to allow for as much pavement build-up as possible to provide as long a merge length as possible. Continue extension of the merge length on a daily basis.

Maintain constant supervision by experienced traffic engineering practitioners to ensure that appropriate traffic provisions are provided and maintained.

5.13 Transit lane during final construction

A number of lane configurations are possible after opening and before final construction is complete. One arrangement is to extend the transit lane over the bridge after opening. This arrangement will result in a varying number of lanes for other traffic over relatively short lengths of road, leading to a confusing road layout. Eastbound capacity will be reduced by half during transit times resulting in substantial queuing and expected driver frustration.

Recommendation

Leave the opening of the transit lane until after final construction is complete and avoid a confusing number of lane additions/lane drops by maintaining a constant number of lanes along Victoria Road and onto the deck while final construction is under way.

6. Conclusions

We have examined the plans and documents listed in Appendix 1. We have inspected the site. The audit has been carried out with the sole purpose of identifying any features of the draft design which could be altered or removed to improve the safety of the project. The problems identified in the proposed road works have been noted in this report. The accompanying recommendations are forwarded for you to consider for implementation.

Fred Schnerring

Steve Levett

Ken Lysaught

Nick Phillips

Col Warne

Note:
Checklists have been used to compile the audit and are filed with the report. They are available if requested however have not been provided as part of this report.

4.3 Sample Road Safety Audit: STAGE 3

Excerpts are reprinted with permission from Transit and Transfund New Zealand.

NEWLANDS INTERCHANGE

SUMMARY OF MAIN SAFETY AUDIT (STAGE 3) COMMENTS

The complications of this interchange in an area severely restricted by topography and existing features has resulted in a comprehensive stage 3 safety audit report (see attached audit report contents page). A summary of some of the key issues are as follows:

Newlands Northbound on Ramp Merge/Johnsonville Off Ramp

The audit recommended the Johnsonville northbound off ramp nose area be reconstructed to provide a full width stopping shoulder past the nose or consider the implementation of taking a 3rd lane past the Johnsonville off ramp, then a standard off ramp arrangement, with a third lane dropped further north.

Solution: First recommendation examined but cost and traffic disruption resulted in decision not to proceed. Second recommendation not practical.

Merge on Newlands Road

Recommendation to lengthen the merge or provide a satisfactory junction between the off ramp and Newlands Road.

Solution: Kerb relocated to provide shoulder prior to motel access.

Southbound Newlands On Ramp Merge

Recommendation to extend length of stopping shoulder proposed south of sign gantry, and provide a width of at least 2.5m, and if possible lengthen the on ramp merging area (from 250m to 325 long).

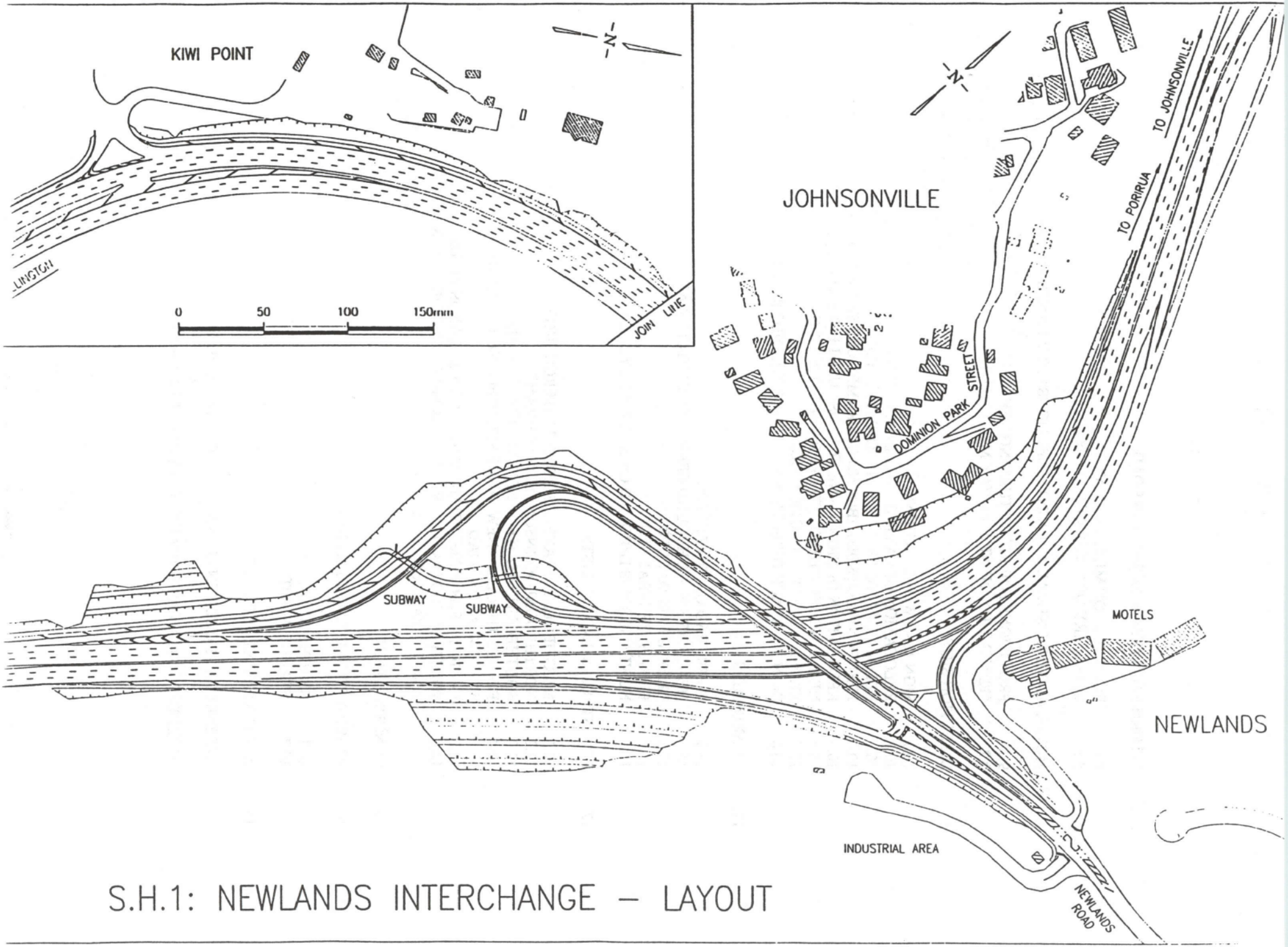
Solution: Because of large cuts involved recommendation not implemented.

Geometry of U-Turn Facility

Concern was expressed over the 8m length of the U-turn facility and that larger vehicles would block the northbound on ramp lane. The safety audit recommend that the U-turn lane be modified by either giving priority to the U-turn movement or increasing the storage length between the two on ramp roadways.

Solution: The U-turn was moved closer to the bridge and the on ramp closer to the hillside. This increased the U-turn length to 13 m.

CONTENTS



S.H.1: NEWLANDS INTERCHANGE – LAYOUT

5.0 EVALUATION OF SAFETY AUDITS

While all agencies that have implemented safety audits have attempted to provide some evaluation of the safety audit process and its effectiveness, TNZ has been a leader in documenting the results of safety audits. It has conducted audits of urban, rural, and existing roads, as well as audits of national highways.

These reviews have focused on the process and the results. The general conclusion is that the audits should be continued, because they have been successful in identifying safety deficiencies. The reports contain recommendations for improving the process (e.g., audit teams should consist of at least two people) and summarize the types of corrective actions recommended.

The report documenting the review of urban safety audits is reproduced to illustrate the extent of these reviews.

5.1 Review of a Selection of Urban Safety Audits

Report reprinted with permission from Transit and Transfund New Zealand.

REVIEW OF A SELECTION OF URBAN SAFETY AUDITS

M. L. Gadd

1. INTRODUCTION

This project has set out to review a selection of urban - mainly intersection - safety audits mostly initiated by Transit New Zealand.

It is now two years since Transit New Zealand published "Safety Audit Policy and Procedures" and the Safety Audit Manager, Dr. Ian Appleton has proposed that a selection of urban, and a selection of rural safety audits be studied to determine the frequency with which topics arose so as to alert designers of the need for care in these areas.

Altogether thirty five urban safety audits were analysed and reviewed. They range from brief reports making three or four recommendations to much larger audits containing up to sixty comments. The table below sets out the total number reviewed in each stage as defined in the TNZ publication:

Stage 1 or Feasibility	5
Stage 2 - Project Assessment	3
Stage 3 - Final Design	8
Stage 4 pre-opening	15
Stage 5 - post construction	3
Not Stated (existing on site?)	2
TOTAL	36

Table 1 - Stages of safety audit reports reviewed

Note: One scheme had both stage one and stage 2 safety audits carried out. The two "not stated" reports were substantiality of existing on-site conditions.

It is apparent from the table that much of the subject matter concerned actual or on-street conditions, as might be expected form the predominance of stage 4 safety audits. Many of the exercises were pilot audits aimed at not only looking at projects but also training potential safety auditors so as to rapidly spread the techniques.

It is not intended to discuss individual reports, or sites, or members of teams, though much of that information is essential background information for a proper and full analysis. A condensed version of each report and a master list of the reports analysed, together with the number of occasions a topic was raised, is included in the accompanying volume not for general distribution: "(2) Topic assignment and Master List"

At the outset of the project it was decided to include as large a sample as practicable to ensure adequate representation of some of the earlier stage and to give confidence in the findings.

1.1. Project Objectives

The project has developed as the pile of reports were scrutinised and analysed. The brief called for an analysis of safety audits to determine the frequency of topics encountered and a summary of which stages were audited. As these objectives involved reading and categorising each report the opportunity was taken to look at other aspects of safety audit. The following objectives emerged:

(a) To study the topics raised and report on the frequency with which topics were included in the reports. (The main objective of the brief)

(b) To see how far the individual comments fitted in to the guidelines topics included in the TNZ Safety Audit Policy and Procedures, August 1993.

(c) To determine how the procedures had been followed, and any significant difficulties which were apparent.

(d) To discover any "problems" that did not fit in with the categories or topics, and if appropriate suggest additions or improvements.

(e) To determine how effective and useful the policy had been in practice.

(f) To comment on the "style" of reporting and make observations on the readability, impact and usefulness of different approaches.

(g) To make suggestions as to how the policy and practice might be improved, both in essence and detail. These ideas are essentially for discussion only and are principally to spark discussion, if and when the Safety Audit Manager considers they are worthwhile pursuing. As is the practice in safety audits I will express each comment as "***Consider etc.***"

It is intended that a summary of important topics and other relevant information will be published in a short report and/or made available to designers, safety auditors and other interested people.

The effectiveness of safety audit is reflected firstly in the acceptance of comments by safety auditors, and in changes to the plans and on the roads themselves. It is possible to find out more about the first of these topics (and this is discussed later), no easy mechanism exists for the second. With the accumulation of data no doubt the effectiveness of safety audit as an accident reducing policy will be tested.

2. METHODOLOGY

(a) It was decided to express the information in each safety audit in a form which could be analysed and comparisons be made between reports. A spreadsheet was developed with the essential facts about where each study was undertaken, who took part, what stage the study was addressing, what was found and what was recommended. This information is included in a separate report.

(b) This process ensured that each report had to be read in some detail. Some quick impressions were jotted down at the foot of each information sheet.

(c) The safety audits studied represented all stages from (1) feasibility to (5) post construction. The concise checklist for stages one to four was adopted from the Policy and Procedures (reproduced in the appendix to this report). With the exception of Stage 1 - Feasibility - the lists have much in common, with topics being added or dropped moving from stage 2 to stage 4. To make the task a little easier it was decided to produce one common list and assign topics to appropriate items. This may seem to be an unjustifiable generalisation but the lists are - by general agreement - no more than auditor's aids (a contagious but benign condition). Recent comments from respected authorities such as Barbara Sabey make clear the view that not too much time should be spent on refining checklists.

What looked at the outset like being a useful, logical, engineering style system, was proving to have an almost minor role. Some analysis might reveal the reason for this or throw up possibilities of improvement or making the list more useful.

(d) A spreadsheet was prepared with a matrix expressing the locality of the safety audits v. the topics (in the general list plus a few additions as explained later), with the actual number being entered into the chart.

(e) These data were further analysed by chart to provide information about the frequency with which each topic was mentioned.

(f) As a matter of minor interest the range of numbers of problems per audit has also been represented graphically.

(g) The range and average size of teams was also determined.

3. ANALYSIS AND SUMMARY OF REPORTS

3.1 The checklists - usefulness, relevance, little used topics

It is apparent that the checklists form no more than an aid to the process of safety audit. Some auditors included copies of the checklist appropriate to the stage being audited and ticked or crossed each topic. Some attempted to use the order of the checklists in presenting the report. (I believe Phillip Jordan adopted this style.) Possibly one common approach was to look at the plans and the site to get a general feel for the job and at a later stage go through the checklist to see if anything had been missed out.

Some items were raised which do not fit easily into any of the topics listed in the checklists, sometimes the problem or comment could not be entered into more than one topic heading. There seems to be no reason why the checklists could not be improved by the addition of missing topics or the wording changed to make the meaning clearer.

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However, in analysing a variety of styles and lengths of report, it is clear that one of the few logical methods of comparison (as opposed to writing long dissertations about each) is to assign each ****Problem**** (also simple "problems" or comments - since not all auditors used the four-star approach) to a topic on a checklist and add up the frequency each topic is selected. The results are expressed in Table 2/figure 1 on the previous page.

However, before discussing this chart, the process of arriving at the form and content offers some useful pointers.

For instance, one difficulty was found in assigning topics. The lists are not entirely logical for this purpose, many topics appearing in the "1a" and "1b" and later on in the list. This was not entirely due to the production of one list, though logically there seems no reason why one extended list with appropriate headings should not work; perhaps be more attractive to auditors than the present multi-list approach.

> ***Consider the idea of one all-inclusive list rather than the present system of have separate lists, often having largely common topics. Consider also remedying deficiencies and grouping topics in a different way.***

Difficulty was also experienced in deciding where to slot each problem. Many of the studies (approximately two thirds) were concerned with existing shortcomings on the road or intersection. This is encouraging from the point of view that audits of existing networks should have value in identifying problems and proposing remedial action - without waiting for the accident rate at any location to flag the location as a problem ("black spot").

However, this aspect was not the main concern (certainly not the authors) in drawing up the present checklist topics. In addition, four topics appear to have been omitted or glossed over:

(a) **Priority controls** as a separate topic (ie. not included in the all-embracing "signs"). The appropriate selection and placing of priority signs has a different connotation from information or street name signs.

(b) The **"speed environment"** seems important. I have been unable to locate a mention of speed in other than Stage 1 - Feasibility. As many audits are of designs which have never been through a stage 1 audit, and even if they had, the actual translation of speed into practice (and at the transition to existing network) is an important matter. This is particularly so since most of the audits dealt with the "built" traffic environment.

(c) **Kerbside activity** seems to be a neglected topic in the lists - not entirely, but with the emphasis on the site conditions, it seems worthy of more than a passing mention. The presence of old or badly sited kerbs is also worth mentioning.

(d) The **road surface** was a topic occasionally mentioned. The lists, based as they largely are on the idea of auditing proposals rather than existing conditions, do not feature any significant mention. The topic can include changes in level, large areas

of (slippery) paint, upstanding service boxes, old kerbs, as well as the condition of the surface (eg. slick with bleeding bitumen, or even ordinary bitumen).

Consider amending the lists - particularly of the later stages - to include the above topics.

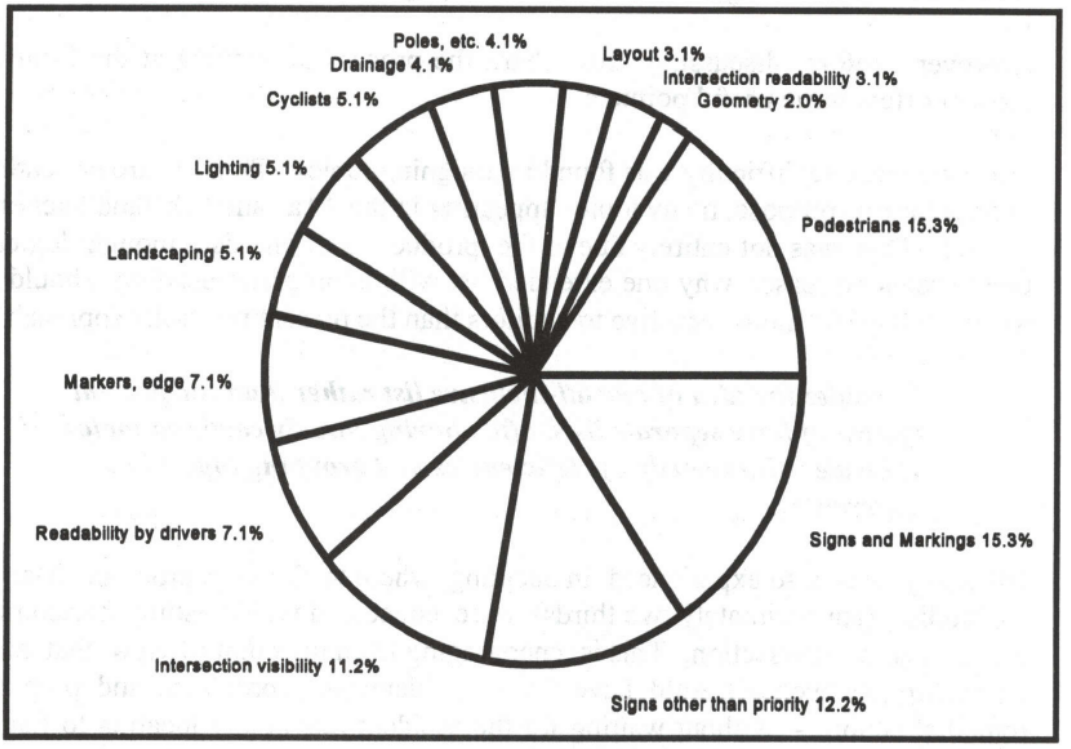

Figure 2 - Split of safety audit subjects between selected topics

I also became acutely aware that the checklists are a mixture of local conditions, traffic engineering, and travel modes. Possibly this is a natural outcome of considering cyclists and pedestrians as being a sort of "add on" to the main aim of dealing with vehicular traffic. This approach is not, in my opinion justified, and one way of dealing with the presentation of the checklists is to separate all vehicular types out of the main list - including "general traffic."

These matters will be covered in greater detail later in the report. The logical step, before analysing the frequency, was to add the missing topics to the present general checklist. Figure 2 (above) illustrates this in diagrammatic form

3.2 The frequency of reference to topics

The chart (Figure 2) on page 5 [previous page] and table (3) on page 6 [this page] convey the strong popularity of topics such as pedestrian safety, signs and markings and readability and the complete neglect of others. Out of the fifty or so possible topics this represents a limited number but is a not altogether a surprising result. It has to be pointed out that the topics are open to different interpretation and a different person scanning the reports might place the emphasis elsewhere in a few cases. For instance I tended to neglect "Traffic management" as being too broad when more detailed and precise slots were available. "Buildability", "operation" are similarly too vague (apparently). "Non vehicular adjacent land" concerns seem covered in "significant adjacent development" (and only three uses, interestingly headed as such).

The lack of use of some items like emergency vehicles, bridges and culverts etc. does not mean that these topics are redundant; they will have their time and place.

For ease of reference, here is a table of the more significant topics (as per table/figure 1):

Ref.	Topic description	Number of refs.
16 (G4/2)	Pedestrians	59
20 (G1b/20)	Signs and markings	56
40 (G5/2)	Signs other than priority	47
27 (G2/1)	Intersection visibility	41
29 (G3/3)	Readability by drivers	28
41 (G5/3)	Markers, edge definition	28
4 (G1a/4)	Landscaping	21
39 (G5/1)	Lighting	21
37 (G4/3)	Cyclists	18
2 (G1a/2)	Drainage	16
43 (G6/2)	Poles and other obstructions	14
28 (G3/2)	Layout	12
24 (G3/3)	Intersections: Readability	10
13 (G1b/13)	Geometry, hor. and vert. alignment	7
22 (G2/1)	Local alignment: visibility	7

Table 3 - The topics most referred to in the sample

The most "popular" topics are to do with movement types and the layout of the road. Many of the balance are collectively to do with vision, a clear unobstructed view of a readable road or intersection. Faults with the road as found are included if they are real safety worries. Some of the specific items mentioned in audits are somewhat distant from safety, but the auditors can be excused as they wish to

point out general faults, including things that are OK now but might go wrong in future.

The main use of the list is to impress on scheme designers, traffic engineers and other the priority of aspects of roads and intersection which are unsatisfactory and potentially accident promoting. Unfortunately, with three exceptions (where reports were included with the safety audit), it has not been possible to quantify or discuss the reactions of the designer and client, still less to observe resultant changes on-street.

The publication of a general list such as the one in table 2 [not included] could be of wide interest to both designers and the safety auditors group, and may help to influence areas being targeted for safety reasons. The publication of this table and discussion at a traffic workshop is one way to go about drawing attention to these matter to the group, and could foster a general discussion at that time.

It may be useful in helping an appreciation of the broad issues to allocate topics to larger groups of common purpose, as mentioned above. These may be termed Physical or general items (involving the road, solid objects), Visibility, and road users.

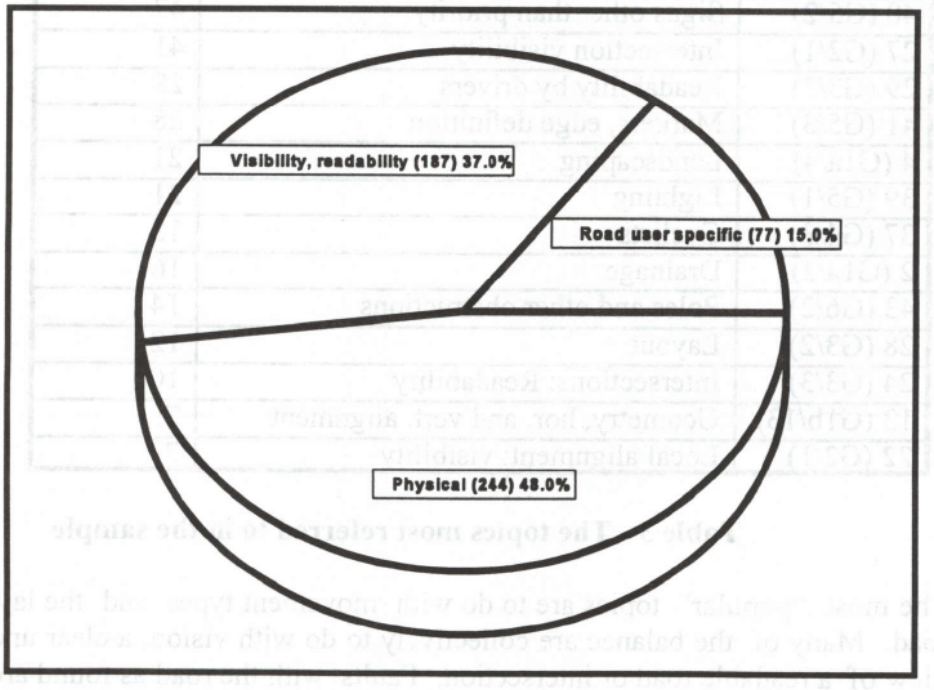

Figure 3 - Allocation of topics to three basic types

MAIN HEADING	Topic reference. Description	Ref.	Freq.	Physical, General	Visibility, readability	Road user	Total % of main heading
G1a General Topics	1.Changes since previous Stage	1	0				
	2. Drainage	2	16	16			
	3. Climatic Conditions	3	33	3			
	4. Landscaping	4	22	11	11		
	5. Services	5	0				
	6. Access to Property and Development	6	8	8			55/11%
	7. Emergency Vehicles and access	7	0				
	8. Future widening &/or realignment	8	1	1			
	9. Staging of scheme	9	1	1			
	10. Staging of works	10	1	1			
	11. Significant adjacent developments	11	3	3			
	12. Batter stability - surface effects	12	0				
G1b Design Approach	13. Geometry of Hor. & Vert. Alignments	13	7	7			
	14. Typical Cross Sections	14	5	5			
	15. Effect of cross sectional variation	15	1	1			
	16. Roadway Layout	16	21	21			
	17. Shoulders, edge treatment	17	4	4			102/20%
	18. Departure from standards & guidelines	18	0				
	19. Visibility, sight distances	19	8		8		
	20. Signs and markings	20	56	28	28		
	21. traffic calming devices	21	0				
Local alignment	1. Visibility	22	7		7		
	2. New/existing interface	23	2	2			
	3. Readability by drivers	24	10		10		
	4. Detailed Geometric Design	25	3	3			22/4%
	5. Treatment - bridges & Culverts	26	0				
G3 Intersections	1. Visibility	27	41		41		
	2. Layout, appropriateness	28	12	6	6		
	3. Readability by drivers	29	28		28		
	4. Detailed geometric design	30	21	11	10		
	5. Traffic signals	31	3	3			113/22%
	6. Roundabouts, islands	32	0				
	6a Controls - Stop / Give Way	33	7	7			
	7. Other intersections	34	1	1			
Non-vehicular	1. Adjacent Land	35	0				
	2. Pedestrians	36	59			59	
	3. Cyclists	37	18			18	77/15%
	4. Equestrians/stock	38	0				
G5 Signs and lighting	1. Lighting	39	21		21		
	2. Signs other than priority	40	47	47			96/19%
	3. Markers, edge delineation	41	28	14	14		
G6 Physical objects	1. Median barriers	42	1	1			
	2. Poles & other obstructions	43	14	14			
	3. Guardrailing	44	7	7			
	4. Bridge & culvert parapets	45	1	1			23/5%
	4a Kerbs, other hard objects wrongly sited	46	0				
G7Construction & operation	1. Buildability	47	0				
	2. Operation	48	0				
	3. Traffic Management	49	1	1			2/0%
	4. Network Management	50	0				
	5. Temporary traffic control / management	51	1	1			
G8 Any other matter	1.Speed environment	52	5	3	2		
	2. Parking, kerbside activity (bus stops etc.)	53	4	4			17/3%
	3. Road surface, met at, paint, skidding	54	5	5			
	4. Other matters	55	3	3			
	TOTALS		507	244	186	77	507
	PERCENTAGE		100	28	37	15	c.100

Table 4 - Allocation of "problems" to topics, and to three basic types

In Figure 3 and table 4, on the previous pages, each topic was allocated to a generic group, as already mentioned. Where topics appeared to fit two groups approximately equally well, the total references to that topic were divided equally between the two. The pie chart in Figure 3 above, illustrates the dominance of the physical and visibility/readability groups. The other groups - the users - at 15% seems to belong to a different field.

As requested in the brief it is suggested that this information and other aspects of this review be distributed to road designers, safety auditors and others who have a role in safety audit so that special attention can be paid to the most common design shortcomings.

4. COMMENTS ON SAFETY AUDITS

It is with some trepidation that I voice opinions about the examples reviewed, and there are no personal or identifiable comments intended, though some may recognise the aspect as being present in their own report.

Firstly, there are no "bad" reports, the standard of expression seems high and easy to follow. There are, however, styles and presentations - and occasionally omissions - that make the reports less easy to follow and therefore less effective.

4.2 Style and presentation

Firstly the broad style. An example is provided in the Policy and Procedure manual. A few followed it literally, some had their own version, many did not even express a gradation of problems. I personally have some difficulty in the use of *****Problem***** (or ******Problem******, or ****Problem****). I agree that a gradation of problem will need to be described. However, not all reports make use of this style, and some of those that do simply put *****PROBLEM***** and put the topic at the top of the first paragraph, so that it is necessary to read the report to find out what is the problem. I believe that three degrees of seriousness will do the job:

SERIOUS PROBLEM:** (followed by location and essence)

PROBLEM :(as above) and

Comment:

(a) Consider reviewing heading/information style and suggesting safety auditors make clear the topic as part of the heading.

Similarly the covers to reports and information on them vary. The pilot audits seem the best, but still lack the stage of audit being carried out.

(b) Consider requesting report writers to state on the front cover the Road or Intersection, its classification, who the report is by, for whom it is intended and what stage is being audited.

The preamble could well now be shortened but required to contain important information. Very few audits gave the duration of the work. A rare inclusion was a locality map; very useful to people reading the report, particularly if they are not familiar with the area, and where several safety audits are being or have been done in the locality helping to understand their spatial relationship.

(c) Consider requesting safety auditors to include a locality or overall plan and providing information about the duration of the study, and any expansion of the data presented on the cover.

Without being dogmatic, it is useful to a reviewer to have a reasonably standard order, presentation style and degree of detail. It would be over regimenting to make this mandatory, our concern would be to make for the greatest impact (and acceptance or clarity of reasons for rejection). A well set out, easy-to-read report goes a long way to achieving these fairly obvious goals.

(d) Consider - particularly if the checklist is revised and abbreviated - providing a pro-forma order for reporting.

On rare occasions a report of an area was difficult to follow, particularly if the order of topic is not related to either a pro-forma order, or a progression through the scheme from beginning to end.

5. THE TEAMS - COMPOSITION AND OUTPUT

An attempt was made to analyse the composition of safety audit teams involved in the sample of 35, and any other useful facts that could be deduced. (This was partly inspired by an article in the Highways and Transportation magazine, June 1995.) It became apparent that the variability of reporting style and inclusion of information made it difficult to determine any factor other than the composition of the teams. Here is a summary of facts that could be determined:

Number	Frequency - in actual team	Frequency- under training	Report by TNZ	Report by Consultant	Report by Local Body Officer
1	1	1	17	11	4
2	11	8			
3	13	5			
4	6				
5	1				

Table 5 - Number of auditors and learners, who wrote the report

The average number of auditors per team was 2.7, with an average of 1 person attending for training purposes. The last three columns are an attempt to determine which organisation was responsible for the actual report.

6. AN OVERVIEW AND COMMENTS ON POSSIBLE CHANGES

In looking at checklists over many days, it struck me that the list or lists lack a logical basis in that they contain all items in a one dimensional list, so that development (planning) rubs shoulders with Poles and bridge abutments (fixed objects) and cycles and pedestrians (moving objects).

This is the point made in the discussion about allocating topics to the three groups - Physical, visibility, road user.

Why not consider a different system where the table consisted solely of non-road user specific attributes, and a matrix created with the road users placed on one axis of this table rather than being mixed up in it.

The result, with some other possible improvements is given in Table 3. The other "improvements" include

(a) abandoning the distinction between intersections and non intersections. Many topics are shared in common; others are so specific that it is not necessary to explain that an intersection is involved - eg. traffic signals, priority controls.

(b) Using the heading "Objects which may be struck or limit design," and adding a few topics.

(c) Using the heading "Assisting the road user - Signs and Lighting."

The changes are largely self-explanatory. They are intended to simplify the checklist to the point where one list can be used for all stages (except possibly stage 1), and for that reason - and the addition of omitted topics and the logic of putting all movement types at the top - safety auditors may be keener on using the checklist.

In any event, any discussion of this new way style of checklist will be helpful in focusing attention on the need or function of checklists in general.

7. STAGE 1 FEASIBILITY

Only three safety audits related to this stage and appeared to deal with the issues very well. The checklist appears to be satisfactory, and with only three sets of topics analysis seemed pointless. However, the topic may justify further attention.

At some future time it may be worthwhile checking to ensure that the topics mentioned are dealt with at stage two or three.

TOPICS LIST / TYPE OF MOVEMENT	A GENERAL	B EMERGENCY VEHICLES	C HEAVY GOODS	D BUSES	E LIGHT TRADE AND CARS	F MOTORCYCLES	G KERBSIDE VEHICLE USE	H CYCLES	I PEDESTRIANS, (a) GENERAL	J (b) MOBILITY IMPAIRED	K EQUESTRIANS	L STOCK, ANIMALS
a Issues and general conditions												
1. Changes since previous stages												
2. Drainage												
3. Climatic conditions												
4. Landscaping, general												
5. Services - buried and overhead												
6. Access to property and development												
7. Future widening &/or realignments												
8. Staging of scheme												
9. Staging of works												
10. Significant adjacent developments												
11. Batter stability - surface effects												
1b General or Scheme Design approach												
13. Geometry of horizontal and vertical alignment												
14. Appropriateness of design speed adopted												
15. Typical cross sections, adequacy												
16. Effect of Cross Sectional Variation												
17. Roadway layout for traffic management												
18. Shoulders, edge treatment												
19. Effect of Departure from Standards and Guidelines												
20. Visibility, sight distance												
21. Signs and markings												
22. Surface, skid resistance												
23. Contrast with markings												
24. Installed hazards												
25. Natural features												
2. Local Alignment including Intersections												
1. Visibility												
2. Readability by drivers and other road users												
3. Correctness of speed design												
4. New/existing road interface												
5. Relationship to other nearby intersections												
6. Layout, geometric design including pavement markings												
7. Traffic signals												
8. Stop and give way signs												
9. Roundabouts, islands, pedestrian refuges												
10. Traffic restraints, traffic calming (all road types)												
3. Objects which could be struck or limit design												
1. Median barriers												
2. Poles & similar obstructions												
3. Guardrailing (vehicle or pedestrian)												
4. Bridge & culvert parapets, underpass soffits												
5. Solid Vegetation												
6. Verandahs												
4. Assisting the Road User -Signs and Lighting												
1. Lighting												
2. Traffic Signs - position and appropriateness, size												
2. Other signs - including distractive (non-road) signs												
3. Markers, edge delineation												
5. Construction and operation												
1. Buildability												
2. Operation												
3. Traffic Management												
4. Network Management												
5. Temporary traffic control / Management												
6 By-law requirements (P)												
66. Safety aspects not already covered												

Table 6 - A different way of constructing a safety audit checklist

8. SUMMARY OF MAIN POINTS AND SUGGESTIONS

8.1 Publish the list of topics raised to increase awareness amongst designers and others

As requested in the brief, it is suggested that this information and other aspects of this review be distributed to road designers, safety auditors and others who have a role in safety audit so that special attention can be paid to the most common design shortcomings.

8.2 One checklist for all stages

Consider the idea of one all-inclusive list rather than the present system of have separate lists, often having largely common topics. Consider also remedying deficiencies and grouping topics in a different way.

8.3 Additional Topics

Consider amending the lists - particularly of the later stages - to include the topics: priority controls, speed environment, Kerbside activity and controls, surface of the road (condition)

8.4 Review presentation of information about each point to make importance clearer

Consider reviewing heading/information style and suggesting safety auditors make clear the topic as part of the heading of each "problem" or comment.

SERIOUS PROBLEM**: (followed by location and essence) or
PROBLEM: (as above) and
Comment:

8.5 Front Cover Information

Consider requesting report writer to state on the front cover the Road or Intersection, its classification, who the report is by, for whom it is intended and what stage is being audited.

8.6 Locality Plan and additional information in introductory paragraph

Consider requesting safety auditors to include a locality or overall plan and providing information about the duration of the study, and any expansion of the data presented on the cover.

8.7 Use pro-forma order for reporting

Consider - particularly if the checklist is revised and abbreviated - providing a pro-forma order for reporting

8.8 A possible different style of checklist

Consider a different system where the table consisted solely of non-road user specific attributes, and a matrix created with road users placed on one axis of this table rather than being mixed up in it.

8.9 Other possible additions and modifications

Consider:

(a) abandoning the distinction between intersections and non intersections. Many topics are shared in common; others are so specific that it is not necessary to explain that an intersection is involved - eg. traffic signals, priority controls.

(b) Using the heading "Objects which may be struck or limit design," and adding a few topics

(c) Using the heading "Assisting the road user - Signs and Lighting"

9. CONCLUSION

The study has highlighted the most common "problems" which could be addressed by road designers. Signs and marking collectively appear to be two of the most common topics. Pedestrians are the number one "problem" ie the possibly needless risk they face through shortcomings in the design. Many of the balance are to do with visibility or readability. Almost half of the topics were related to the physical road environment, approximately a third to do with visibility or readability and the balance related to specific vehicle movements.

As this report is an analysis of only a few aspects of the safety audits carried out, it would be presumptuous to suggest that radical changes should be make to the form and practice. However, there are changes to the report style or layout which would assist the understanding of each report and how it compares with others.

This would also assist if at any time in the future, an evaluation were to be carried out as to the cost effectiveness of the process, and how effective it is in firstly, persuading designers to change their plans, secondly whether the accident rate has been reduced either at individual site or en masse (at schemes which have been safety audited). I suggest that consideration be given to defining and setting up such a project.

The inclusion or omission of any item covered in the list of consideration is a matter for the Safety Audit Manager to decide. The suggestions made in the report and summarised above seem worth looking at if and when changes to the procedures are made. Possibly a session of a representative group of designers and safety auditors could discuss them and/or the approved topics could be aired at the forthcoming 27th Traffic Management Workshop.

International Technology Scanning Reports

Highway Information Management

__ National Travel Surveys (September 1994)
__ Traffic Monitoring (June 1996)
__ National Personal Transportation Studies (October 1993)
__ Acquiring Highway Transportation Information from Abroad - Handbook (1994)
__ Acquiring Highway Transportation Information from Abroad - Final Report (1994)

Intermodal Transportation

__ European Intermodal Programs: Planning, Policy and Technology (September 1994)

Pavement

__ Highway/Commercial Vehicle Interaction (1996)
__ South African Pavement and Other Highway Technologies (May 1997)
__ European Asphalt (1990)
__ European Concrete Highways (1992)

Policy

__ International Decision Making Criteria for Highway Investment
__ International Contract Administration Techniques for Quality Enhancement- CATQEST (June 1994)

Safety

__ Pedestrian and Bicycle Safety in England, Germany and the Netherlands (October 1994)
__ Bicycling and Walking in the Nineties and Beyond (1994)
__ Highway Safety management Practices in Japan, Australia, and New Zealand (June 1995)
__ Speed Management and Enforcement Technology (February 1996)
__ Road Safety Audits--Final Report (October 1996)
__ Road Safety Audits--Case Studies (October 1996)

Structures

__ Geotechnology - Soil Nailing (June 1993)
__ European Bridge Structures (1996)
__ Northumberland Strait Crossing Project (July 1996)
__ Bridge Maintenance Coatings (January 1997)
__ Repair/Rehabilitation of Bridges Using Fiber-Reinforced Composite Materials (October 1996)

Research and Development

__ Scanning Report on Advanced Transportation Technology (December 1994)
__ Human Factors Technology for Highway Design (May 1995)

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